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SECRECY AND SECURITY IN ATOMIC RESEARCH

THE recent debates in Parliament on the Defence Estimates, and the "Statement on Defence, 1954"* on which they centred, were marked by a candour which has often been absent from such debates and by a keen appreciation of the need for informed public discussion of the broad issues, though it was impossible, for security reasons, to discuss details or the magnitude of the effort in particular directions which is being undertaken in Great Britain. In that of atomic energy, for example, Dr. J. B. Conant has expressed the opinion that no full public discussion is possible within the foreseeable future. The subsequent hydrogen bomb developments may well, however, enforce somewhat fuller public discussion, at least on such issues as the apportionment of resources between research and production in different fields of defence and between defence research and civilian research. Moreover, quite apart from the implications of President Eisenhower's proposals of last December for an international atomic pool under the United Nations, and his subsequent message to Congress on February 17 asking for changes in the Atomic Energy Act of 1946 to facilitate wider co-operation with the allies of the United States in the interchange of information concerning the use of atomic weapons, the processing of atomic raw materials, reactor development, production of fissionable materials and related research and development, strong support for more freedom in the exchange of information has been forthcoming from responsible quarters inside as well as outside the United States.

In an article in *Foreign Affairs* last summer, Dr. J. R. Oppenheimer, formerly director of the Los Alamos Laboratory, discussing atomic weapons and American policy, urged more candour in making available to the public the information necessary for informed discussion of the factors which limited the country's choice of action. That is as essential in other countries as in the United States if governments are to be assured of the firm support of intelligent public opinion in the difficult decisions they are called upon to take. This argument is well illustrated in the introduction to the Statement on Defence, 1954. Dr. Oppenheimer equally stressed the need for more candour on the part of the United States in dealing with its major allies. Here he referred both to technical collaboration and to the military collaboration, for which both General Bradley and General Collins had pressed as a precondition of effective planning and successful defence of Europe. Dr. Oppenheimer also argued that more candour is an essential factor in securing public co-operation in the measures of civil defence required to moderate the dangers from atomic weapons or other means of enemy attack on the civil population, and the soundness of his arguments is well indicated in the reactions of some local authorities as well as of individuals in Great Britain

* Statement on Defence, 1954. Pp. 26. (Cmd. 9075.) (London: H.M. Stationery Office, 1954.) 1s.

to the statements in the press regarding the hydrogen bomb explosions of March 1 and later.

Mr. Gordon Dean, former chairman of the United States Atomic Energy Commission, in his subsequent book, "Report on the Atom", takes a similar view. Mr. Dean believes that, in the absence of informed public discussion, the United States decision to build up a stockpile of atomic bombs, which became the most important single factor in planning its strategic defence, resulted in the stockpile being carefully concealed so that nothing could be done with it except under the most extreme conditions and with much soul-searching at home and a loss in reputation for morality abroad. This situation gave the U.S.S.R. much more freedom of action in the post-war world than they would otherwise have had, and although Mr. Dean is a convinced believer in the deterrent value of the atomic stockpile, he gives no high place to secrecy in his proposals for improving the security of the United States and the free world. Progress in science, he recognizes, has no international boundaries or special environments, and leadership in the atomic field will be maintained by achievement, not by a cloak of secrecy.

This welcome reminder that security and secrecy are not synonymous—and may even be inconsistent—comes, not from a scientist but from a lawyer-administrator, who sees as the goal over the next few years a wide base of co-operation between the scientists and engineers of the United States and Great Britain in the field of atomic energy, conducted in such a way that the Soviet programme is not advanced. There is thus already much support for President Eisenhower's proposals from responsible opinion, both civil and military, in the United States, and it is desirable that discussions of defence policy and of the functions of the Atomic Energy Corporation Bill should be so conducted as to put no fresh obstacles in the way of Anglo-American co-operation and the interchange of information. For the same reason, scientists should do what they can to put discussion of hydrogen bomb developments on a factual basis. Calm judgment and clear thinking, not partisanship or passion, are the way to security.

In his article referred to earlier, Dr. Oppenheimer agrees with Dr. Conant that to-day public opinion does not exist in the field of atomic energy; he pleads particularly that knowledge of the characteristics and probable effects of atomic weapons, of—in rough terms—the numbers available, and the changes that are likely to occur within the next few years, and our general estimate of where a potential enemy stands, are not among the things to be kept secret.

The Civil Estimates for 1954–55 disclose for the first time the magnitude of the national expenditure in Britain on the development of atomic energy, though that on atomic weapons is still concealed within the Service estimates and those for the Ministry of Supply. Nevertheless, the Statement on Defence is a first tentative step towards a public discussion in general terms and itself points to some of the essential questions to be asked, while others emerged in the debates in the House of Commons.

First, the Statement emphasizes the heavy burden on the economy of Britain imposed, not merely by the magnitude of the Defence Estimates themselves but also by the continuing need to devote to defence production a substantial part of the output of the engineering industry. It is thus still necessary to hold a careful balance between the demands of defence and those of other sectors of the economy and, in particular, to ensure by close co-operation with our partners that our share of the common burden does not impose an undue strain on our balance of payments: "Our armed forces cannot, in these circumstances, be provided with all those things which ideally they should have".

That being so, there are two fundamental questions to ask. The first concerns the effectiveness of collaboration with our partners. There should be no possibility of the cost of security being confused with the cost of independence. Cool, impartial public discussion, when well informed, is a real safeguard against the duplication of research and prototypes, and a powerful stimulus to politicians to create the political conditions which further cheaper and more efficient defence.

The second question relates to the balance of the national effort in Britain, both that between defence and civilian research and development, and that between conventional and new and unconventional weapons. It is here that the biggest problems are now emerging, as the Statement on Defence indicates; and while public discussion could help at least in ensuring support for the difficult decisions which must be taken, it can only help if such discussion is serious and responsible as well as informed. The defence policy outlined is based on the prevention of war and accepts the necessity of keeping our present lead in technical development to offset weakness in man-power. Only by implication is it recognized that Great Britain's foreign policy should be in keeping with the resources available to support that policy, and one of the most striking features of the references to man-power is the absence of any reference to the point made by Sir Godfrey Ince in his paper to the Manchester Statistical Society last year regarding the use of man-power: both in industry and in the Services it is essential that the most fit and active should not be employed on tasks or duties which could be done as well by older and less active men. The point was indeed taken up by speakers in the debates in Parliament, but in respect of the employment of women in the Services.

There may, of course, be room for argument as to the respective roles of the three Services in the overlapping and conflicting tasks arising out of the policy set forth in the White Paper. As to the situation created by the atomic weapons which are already being delivered to the Forces, and by the guided missiles, which have reached an advanced stage of development, the major clash of opinion arose as to the change which should be made in the direction and balance of the research effort of Britain. Moreover, the White Paper itself points out that the balance between new and conventional weapons can only be decided over a period of years in the light of

the situation as it develops, and of the studies in the problems of tactics and training created by the new weapons which are proceeding both in the United Kingdom and under the North Atlantic Treaty Organization. The hope is expressed that these studies will gain in realism and effectiveness as a result of President Eisenhower's request to Congress for legislation permitting the release of more information on the use and effects of nuclear weapons.

Summing up, it is clear that the central theme is the need for the freest exchange of information consistent with national security. At different levels, different criteria will obviously have to be applied. So far as the general public is concerned, sufficient general knowledge relating to atomic energy and to atomic weapons should be made available to enable people to appreciate not only the magnitude but also the limitations of recent developments; by these means alone can a reasoned and balanced view of affairs be achieved. At more specialized and technical levels, the amount of information which can be exchanged must be assessed on a different basis; but secrecy for its own sake has always been a friend of wastefulness, inefficiency and duplication such as can ill be afforded at the present time.

THE NANYANG UNIVERSITY, SINGAPORE

THE proposed Chinese University in Singapore (called "Nanyang" after the Chinese name for South-East Asia) stems immediately from the separate system of Chinese schools in Malaya, but more basically from a deep urge in the Malayan Chinese to preserve their cultural independence. Throughout the country there exist, side by side, English schools (primary and secondary) and Malay, Chinese and Tamil vernacular schools. The latter have far more pupils, but only the Chinese schools constitute a system paralleling the English schools right up to secondary level, and also largely independent of Government help and control. Their main medium of instruction is Chinese, and the English which all their senior pupils learn is not usually enough to qualify them to enter the country's established University, the University of Malaya, where English is the medium of instruction and academic standards are those of the universities of the United Kingdom. Most of its students are indeed Chinese; but they nearly all come from English secondary schools.

Boys and girls from Chinese schools seeking a university education have hitherto commonly gone to China. To-day that has obvious difficulties and disadvantages. Education in China is education in Communism. Those who go there find it hard to return and may be lost to their families and to Malaya. More and more are thus left with no clear avenue to any university. Actual numbers are small; Chinese school pupils are said to total 400,000 against 211,000 in English schools; but whereas there were 4,339 in English School Certificate classes last year, the corresponding Chinese school classes had only 418, of whom but a fraction will actually seek a university education.

However, the problem, if far smaller than sometimes suggested, is real, and it was primarily to solve it that a group of wealthy Chinese proposed last year to create a new Chinese university in Singapore. They spoke also of providing a centre for the study of Chinese culture and of supplementing the work of the University of Malaya by teaching subjects not yet offered there; and, in answer to a charge of communalism, they proposed to cater for Malayan residents of other races, too.

An initial fund has now been raised, a site decided upon, building plans prepared and—a most important step—a chancellor and a vice-chancellor selected, in the persons of Dr. Lin Yu Tang and Dr. Robert Lim. With one initial promise of 5,000,000 dollars and smaller donations and promises, funds available may be upwards of 7,000,000 dollars local currency (say £800,000). That is no more than a start towards the cost of a modern university; for comparison, the University of Malaya already costs about £650,000 per annum, and the cost of rebuilding it on a new site was put at £17,000,000.

The chancellor is to be the active chief executive, and many decisions may be postponed until Dr. Lin arrives (probably in September) and familiarizes himself with an atmosphere hitherto strange to him. Meanwhile, no academic appointments have been announced; legal authority to issue degrees has still to be obtained; the steps to be taken to guarantee their standard have still to be defined; and no formal announcement has been made of the basis of admission of students. None the less, teaching is planned to start early in 1955, using temporary or borrowed buildings. Initially there are to be Faculties of Arts and Science only and, rather surprisingly, teaching is to be largely in English. The first is a wise decision; it would have been over-bold to tackle fields such as engineering, which the University of Malaya has found too difficult hitherto but will in any event be entering soon.

Certain questions inevitably arise. First, could not a ladder to university education be more easily provided by bringing the Chinese school pupils up to the standards in English language of the University of Malaya, or by giving some teaching in the University in Chinese? The problem is not solely one of language, for there are other marked differences existing in the basic educations given in the English and the Chinese schools; but possibilities of adaptation or extension of teaching in their senior classes or of otherwise bridging the gap between them and the University of Malaya are under active examination. However, the sponsors of the Nanyang University decided that only a quite separate institution could serve their purposes.

Secondly, is the new institution needed for the study of Chinese culture and literature? Long delays had raised doubts whether the University of Malaya would ever give reality to the Department of Chinese Language it had long possessed on paper; but the

appointment last summer of a head of that Department and the purchase of some 80,000 volumes as the basis of a Chinese library have made clear that it does not intend to neglect that field.

Thirdly, what will be the value to the practical-minded student of a Nanyang University degree? Much will depend on the recognition given locally, for example, for Government appointments, and on whether good English continues to be essential in the professions and the other higher appointments to which the local graduate aspires. If the new University offers no reliable avenue to local employment, will it prove an effective counter-attraction to a university education in China, offering a definite avenue to employment there? The answer may depend on whether the Chinese school pupil really wants an education for China or an education for Malaya.

Fourthly, can any university in Malaya to-day establish and maintain itself without constant re-inspiration and reinforcement from outside, as the University of Malaya is inspired and reinforced by its close contacts with the Commonwealth universities? If not, where is the Nanyang University to find such reinforcement outside China?

Hitherto the Chinese in Malaya has had to choose, for his higher education, between a Western system in Malaya or a Chinese system in China. The Nanyang University seeks to offer the alternative of a system geographically in Malaya but culturally inspired by Chinese thinking. It is yet another mark of the great and vital interest taken in education by people of Chinese race, and an interesting experiment in a mixed society of confused cultural loyalties and linguistic habits; but it fits very uneasily with the political aspirations of Malaya to a united and integrated nationhood.

FOUNDATIONS OF MODERN PHYSICS

A History of the Theories of Aether and Electricity

The Modern Theories 1900–1926. By Sir Edmund Whittaker, F.R.S. Pp. xi+319. (London: Thomas Nelson and Sons, Ltd., 1953.) 32*s*. 6*d*. net.

IF a younger physicist is to review a new book on the history of physics, and if the author of the book has grown up with all the events about which he is writing, then the reviewer is in a difficult situation. Unlike the author, he has not grown up with the material, but has only absorbed the latest stage of the physical theories during his student days and subsequent work, so that he is not familiar with many details in the historical development of even the past fifty years. To review such a book and comment on the historical correctness and completeness of the work, he must study the history of science, and only then is he in a position to make some criticisms. But in regard to this book by Sir Edmund Whittaker, a reviewer must do much more: it warrants a thorough study of physical literature since 1900 before one has the right to make such a statement as: "I do not agree with this or that" or to put one's finger on a mistake.

If one asks why has such a book been written, the answer could be: to spare other people the necessity of reading the enormous amount of scientific papers of the period in question in order to understand the historical evolution; and it is in the attainment of this objective that I feel competent to comment. Before doing this, however, let me return for a moment to the question of historical accuracy. Extrapolation is a well-known scientific technique, and I think it is possible by means of extrapolation to judge even on this question. One need read only a few pages of the book to sense the thoroughness and conscientiousness of the whole work. Furthermore, one will note that no statement is made without being justified by at least one quotation, the total of which I estimate to be more than a thousand. Thus, from this great number of quoted papers, from the personal experience of the author and from the general solidity of the work one may conclude that it is historically complete, for it is inconceivable that an author with such a profound knowledge of his sources could have overlooked any important fact. Indeed, one can rather be sure of the historical objectivity from the thoroughness and the style of this work.

If it be doubted that a younger physicist can make valid criticisms by means of the method of extrapolation, there are indeed three other features of such a work on which he can comment: the extent to which the book fulfils its purpose; the effort it demands from its reader; and one's reactions on reading the work.

Taking the first of these points, the number of facts considered in the 307 pages of text is astonishing. They are not superficially described, but form a carefully ordered and profound analysis of the development of theories. Many of the papers quoted are forgotten to-day; but the ideas do nevertheless form a part of present-day science, and it is impossible to understand the evolution of science without them. But Sir Edmund does not confine himself to enumerating the facts or describing them in simple words. He brings the reader to real understanding by a coherent mathematical description enabling him to follow the development step by step—though, indeed, only if the reader is willing to make a co-operative effort. Besides this, the book can also be used for reference purposes and as a collection of sources. Therefore it is essential for any library.

Turning now to the second point, the book is not written for the layman interested in the history of science, and certainly does not belong to the category of popular science books. The reader should possess a knowledge of differential and integral calculus, tensor calculus, matrices as required for Maxwell's theory of electricity, relativity and quantum theory. But it will suffice if one's knowledge of these topics is somewhat sketchy, because the author gives some assistance, as, for example, by a short introduction on tensor analysis and matrices. The contents of the book can be indicated by the following list of chapter headings: the age of Rutherford; the relativity theory of Poincaré and Lorentz; the beginning of quantum theory; spectroscopy in the older quantum theory; gravitation; radiation and atoms in the older quantum theory; magnetism and electromagnetism; the discovery of matrix mechanics; the discovery of wave mechanics.

How does the reader feel about this book—or rather, how did I feel? The clarity and the excellent didactic construction make it a pleasure to follow

Sir Edmund through the years 1900–26, though his book is sometimes not easy to read because of the condensed style and the fact that he often employs the nomenclature used in original work instead of that which would be used to-day. But this is surely an advantage and not a fault.

Besides the history of physics, one may learn from Sir Edmund one very important fact, namely, that it was of no advantage to have been living fifty years ago in order to make some of the great discoveries which to-day seem to be so easy and self-evident. From this book one can see that things were then much more complicated than they may now seem; in fact, they were just as difficult for physicists of that time as present problems are for us.

R. HAGEDORN

EVOLUTION OF THE HUMAN MIND

Anthropogenesis

A Study of the Origin of Man. By Prof. Ant. Pannekoek. Pp. 120. (Amsterdam: North-Holland Publishing Company, 1953.) 12*s*.

A THOROUGHGOING analysis of human origins would encompass the physical, the social and the psychological distinctions of *Homo sapiens*. It would indicate the phyletic stage and ecological setting in which hominid features first appear and attain their full expression. For much of what is essentially hominid begins to be recognizable all the way back in the Primate progression, and the transition from prehominid is never likely to be a sharp one. There are characters, too, which are closely interdependent, and a case could be made for their developmental, and perhaps genetic, correlation. Weidenreich, for example, has directed attention to the interacting changes characteristic of the transformation of the face and brain-case and the bending of the basicranial axis. Already, palæontology and comparative primatology, guided by the broad principles of animal evolution, offer enough to make the biological exploration of anthropogenesis a fascinating, if complicated, intellectual exercise.

Prof. A. Pannekoek's exploration scarcely touches on the biology of the matter. It is a long, sustained disputation of a hypothesis to account for the genesis of conceptual thinking, language and tool-making. The thesis is skilfully and forcefully argued and is worth following if the reader will bide his time in the opening discursive chapters and be prepared to go in and out of several neurological blind alleys. The theory is an amalgamation and re-ordering of a number of interrelated propositions which have been argued before. These are, briefly, that tool-making implies a developed capacity for conceptual thought (an idea elaborated by Elliot Smith), that speech and conceptual thinking develop reciprocally (as Darwin, ignored by the author, postulated) and, to complete the logical triad, that word-making is closely "akin to tool-making" (Charles Bell). Prof. Pannekoek examines and dissects each of these postulates in detail and finds them intrinsically convincing, though there is scarcely a material check which can be brought to bear on his premises or inferences. He urges the primacy of tool-making as the driving force in the development of the faculties of human thinking and speech, though he emphasizes that, once started, all three activities would undergo a continuous mutual development. A point he labours is that "simple Darwinism" has led biologists to ignore the cultural factor of tool-making as the most potent agent of cerebral and mental development. But he himself quotes many writers who have accepted this possibility, though perhaps not to the extent of the author himself. There are places where the argument is not clearly developed. The enlargement of the brain is regarded in the main as a resultant of tool-making (p. 78), but some degree of enlargement is apparently a precondition in the earliest stages for cultural development (p. 107). Pannekoek criticizes, and with some justice, Elliot Smith's essentially orthogenetic view of brain expansion.

On Pannekoek's thesis, a protracted period of tool-using and of slow improvement in tool-making with concomitant lagging in brain development must have taken place (the palæontological record supports this) with word use emerging relatively late. Interestingly enough, Prof. R. J. Pumphrey has recently[1] made a similar inference using less speculative arguments derived from the physical and physiological nature of language. Unlike Prof. Pannekoek, Prof. Pumphrey puts forward a piece of collateral evidence. He infers that the ability to use the "degenerate symbols" of language became increasingly manifest during the Upper Pleistocene; he suggests that this is mirrored in a pronounced tendency for the representational art of that period to exhibit progressive abbreviation and abstraction. The biggest omission in Prof. Pannekoek's discussion is the scant attention given to the emergence of the human social grouping in the development of the faculties of speech and thought.

J. S. WEINER

[1] Pumphrey, R. J., "The Origin of Language. An Inaugural Lecture". (Liverpool University Press, 1951.)

METHODS OF ORGANIC CHEMISTRY

Methoden der organischen Chemie

(Houben–Weyl.) Vierte, völlig neu gestaltete Auflage. Herausgegeben von Eugen Müller, unter besonderer Mitwirkung von O. Bayer, H. Meerwein und K. Ziegler. Band 8: Sauerstoffverbindungen 3, Peroxyde, Kohlensäurederivate, Nitrile und Isonitrile, Carbonsäuren, Decarboxylierung, Carbonsäureester, Funktionelle N-Derivate der Carboxylgruppe. Pp. xviii+776; 1952; 98 D. marks. Band 2: Analytische Methoden; pp. xxiii+1070; 1953; 139 D. marks. (Stuttgart: Georg Thieme Verlag.)

THE appearance of the first two volumes of a completely new edition of "Houben–Weyl" is a notable event in organic chemical circles. The third edition, of which Vol. 1 was issued in 1925 and Vol. 4 in 1941, enjoyed great popularity which is far from dissipated even now. In the fourth edition the subject-matter has been completely rearranged, and the articles in the two volumes now under review have been enlarged and modernized out of all recognition. The names of the contributors (for example, R. Criegee, H. Henecka, F. Arndt, B. Eistert, H. Roth, Th. Wieland) as well as of the editor and his associates are sufficient guarantee of the authenticity and quality of the work. Serial publications such as

"Organic Syntheses" and "Organic Reactions" and the series of Theilheimer, which have proved invaluable to the synthetic organic chemist, have in no way lessened the importance of "Houben–Weyl", which indeed gives extensive references to articles in the first two of these publications. A large proportion of all the references relates to original papers published after the third edition, and they include reference to many patent specifications and to FIAT reports and reviews.

Vol. 8, published in 1952, was the first volume of the new edition to be issued. It is said that the complete edition will consist of about fifteen volumes. Criegee contributes an article on peroxides, which gives an interesting survey of the several different types of preparative methods now available and contains a short section on the reactions and uses of peroxides. Derivatives of carbonic acid are dealt with by S. Petersen and H.-F. Piepenbrink in two comprehensive sections in which, for example, the reactions of cyanic acid, cyanogen halides, cyanamide, urea and guanidine are summarized in convenient tabular form. Various classes of dimeric and trimeric carbonic acid derivatives are described, and the part dealing with biguanide refers extensively to the publications of F. H. Curd and F. L. Rose and their collaborators in the researches leading to new antimalarial drugs. A long section on nitriles (by P. Kurtz) includes preparative details for anhydrous hydrocyanic acid, cyanogen and acrylonitrile, and contains also a few pages devoted to isocyanides.

The next section is concerned with the preparation, transformations and decarboxylation of carboxylic acids. This covers a whole range of interesting organic reactions. There are descriptions of methods for the direct introduction of the carboxyl group using carbon monoxide or carbon dioxide, of oxidation routes to carboxylic acids, of synthetic methods such as the acetoacetic ester and malonic ester syntheses, the Perkin and Knoevenagel reactions, and of rearrangements such as the benzilic acid change, the Arndt–Eistert reaction and the Faworsky reaction. Decarboxylation comprises not only direct elimination but also rearrangements such as the Curtius and Schmidt degradations. Equally interesting and useful is the section on carboxylic esters, which gives examples of well-known condensation reactions. These include the Reformatsky reaction, the Darzens glycidic ester synthesis, Claisen's ester condensation, the Stobbe synthesis and the Michael reaction. These examples illustrate, incidentally, the use of the majority of the extensively used condensing agents; but the usefulness of the article would have been enhanced by including a discussion of their relative merits with an indication of the reagent of choice for specific types of reaction and molecular environment. The last section, dealing with nitrogenous derivatives of carboxylic acids, is followed by an author index containing all the names in the footnote references throughout the volume, and a subject index which is largely a list of names of compounds; page numbers of preparative methods are given in heavy type.

Vol. 2, issued in 1953, contains a most valuable comprehensive survey of the methods of analysis and the determination of physical constants of organic compounds. There is a detailed description of qualitative elementary analysis, and the quantitative section rightly gives most prominence to micro- and hemimicro-methods. The determination of oxygen is included among the methods of elementary analysis, and also the estimation of silicon in organic silicon compounds and of metals in organo-metallic compounds. The 248-page section on elementary analysis concludes, appropriately enough, with a glimpse of the future in the shape of a brief survey of methods of 'ultramicroanalysis' by which, for example, combined carbon, hydrogen and oxygen estimations can be carried out with quantities of the order of 100–300 μgm.

Other analytical methods relate to the determination of specific molecular groups, to gas analysis (including adsorption methods and spectroscopic methods), thermal analysis of molecular compounds, chromatographic analysis and analysis of solvent mixtures. The chromatography section gives a detailed illustrated description of experimental methods, including paper chromatography and the use of ionic resins. In connexion with paper chromatography, it is curious that although the name of A. J. P. Martin appears in the literature references, no mention is made of R. L. M. Synge. Errors in transcription of names are easily made; one of the references in Vol. 2 gives A. C. Cook instead of A. H. Cook, and in Vol. 8 G. M. Bennett appears as G. M. D. Bennet. The section on gas analysis has a table of physical constants of upwards of forty gases, and this section is followed by a section on the determination of melting and freezing points, and of boiling and condensation temperatures. A valuable feature of this volume is the inclusion of a general bibliography at the end of most of the articles.

It is unnecessary to commend these two excellently produced volumes to organic chemists. They will be attracted to them instinctively.

J. W. Cook

MAGNETIC CHARACTERISTICS OF ROCKS

Rock-Magnetism

By Prof. Takesi Nagata. Pp. viii + 232. (Tokyo: Maruzen and Co., Ltd., 1953.) 5 dollars.

THE present interest in the interpretation of the natural residual magnetism of both igneous and sedimentary rocks makes this survey by Prof. T. Nagata of the characteristic magnetic properties of rocks most opportune. Of necessity, any interpretation of the observed natural magnetic polarization must be based upon a full appreciation of the magnetic behaviour of the rock constituents. The main geophysical problem is the cause of abnormal directions of magnetization, differing widely from that of the present earth's field, in many cases being in opposition to it. Two hypotheses have been advanced to account for this phenomenon: one requires large changes in the direction of the earth's field in the past, and the other seeks to explain the reversed polarization in terms of the intrinsic properties of the ferromagnetic constituents and their possible interaction under suitable physical conditions in a normal earth's field.

The opening chapter of the book is of a general nature and gives a brief review of modern ideas on magnetism, with special reference to ferromagnetic materials and the theories, advanced by Néel, of the behaviour of small ferromagnetic particles. It concludes with a review of the more common magnetic

minerals occurring in rocks. The next chapter is on the measurement of rock magnetism which, because of the small intensities of magnetization, requires special techniques. The usual magnetic properties—that is, hysteresis and the associated values of saturation intensity, coercivity and remanence, the effective susceptibility in weak fields, the variation of properties with temperature, Curie temperature, etc.—have one chapter devoted to them. In particular, the rock, regarded as an assemblage of mineral grains, and the relation between properties and concentration of minerals, are treated in some detail.

By far the most valuable, and longest, chapter is that devoted to the thermoremanent magnetism of igneous rocks, for it is this aspect which is of greatest significance in the interpretation of natural residual intensities. The author has made his most important contributions in this branch of the subject, and our knowledge of the details of the manner in which a rock acquires its large and stable intensity when cooled from above its Curie temperature is largely due to his work. The amazing behaviour of the dacite from Mt. Haruna which, when cooled in a weak field, acquires a polarization directed in opposition to the ambient field, is also discussed. Of the last two chapters, one is concerned with the magnetization of sedimentary rocks while the other considers some of the geophysical problems which arise from the general subject.

As a compilation of experimental data of the properties of rocks, mainly under laboratory conditions, this book is valuable; but the interpretation of the results is not always satisfactory or carried out in a sufficiently critical manner. As an example of this, a relation is deduced between the effective susceptibility of rocks in weak fields and their magnetite content. The observations show such a wide scatter that the value of the numerical interpretation is open to question and a significance test is essential for its full appraisal. Again, many of the conclusions are not generally accepted by other workers, particularly that on the mechanism by which the Mt. Haruna dacite acquires its adverse polarization. The book is well printed and generously illustrated. One major fault—for which Prof. Nagata is not responsible—is the English, which leaves much to be desired.

J. M. BRUCKSHAW

WEATHER NEAR THE GROUND

Micrometeorology

A Study of Physical Processes in the Lowest Layers of the Earth's Atmosphere. By Prof. O. G. Sutton. Pp. xii+333. (London: McGraw-Hill Publishing Co., Ltd., 1953.) 61*s*.

DR. SUTTON has written the book that only he could write; and there will be a warm welcome for this illuminating survey of territory that he himself has done so much to extend. A flippant reviewer will perhaps be forgiven for suggesting that the sub-title ought to be "Mathematical Processes in the Lower Atmosphere", for this is a mathematician's book with the scope and content of which there could be little quarrel were the design limited to producing a survey of postgraduate standard for mathematicians and physicists. The author, however, specifically states that he has attempted to meet the needs of workers in other fields who require detailed information about physical processes in the regions of the atmosphere where life is most abundant. To these other workers—biologists and the like who make up the great bulk of practising micro-meteorologists in the world—the book will be difficult where it is relevant, and disappointing where it is silent on what they regard as the important problems of micro-meteorology: air movement, temperature and humidity gradients inside crops and forests; the physical environment of insects and animals; the dispersal of atmospheric plankton with non-negligible terminal velocities of fall; and wind erosion, to name only a few. At present, of course, the meteorologist can do no more than provide a qualitative discussion of the physics of some of these problems; but a lead from Dr. Sutton would have been invaluable in stimulating thought and experiment.

The first of the eight chapters clears the way for later arguments in describing the static properties of the atmosphere. The next two deal with air moving in laminar flow and turbulent flow, the former primarily to set out and explain the basic aerodynamic equations and to introduce the concepts of shearing stress, viscosity and mean free path. Against this background there is an extended survey of mixing length theories in turbulent flow, first on the molecular analogy of Prandtl and then on the statistical basis initiated by Taylor. The analysis at this stage is mainly used to derive velocity profiles over smooth and rough surfaces, and the corresponding momentum transport constants. Here, as elsewhere, the mathematics is crisply set out and the argument uninterrupted: but at the expense of a discontinuity it would be helpful to have some discussion of the physical implications of these differing concepts of mixing length.

After considering the transport of heat in free convection, diffusive processes are studied in general terms that permit the analysis to be applied not only to heat transfer but also to imponderables in the atmosphere—water vapour, smoke and other pollution with negligible terminal velocities of fall.

The chapter on radiation is pure meteorology and includes an extended treatment of long-wave radiation leading to a discussion of the possibilities of predicting night minimum temperatures. As 'micro' meteorology this chapter might well have included some discussion of radiation exchanges between small bodies and their environments, a topic of wide importance in most branches of outdoor biophysics, particularly in the measurement of temperature. Almost every temperature measurement involves an uneasy compromise between adequate shielding from radiation and adequate exposure of the element to the environment. A section on the micro-meteorology of meteorological instruments would be a very welcome addition to a future edition of the book.

The remaining three chapters of the book take the mathematical analysis of the first part into the field to match formulæ against facts. Temperature distribution and heat flow are considered after a preliminary survey of the heat balance at the earth/air boundary; from temperature, on to wind, with details of wind profiles over rough surfaces and the influence of atmospheric stability on them. Read in conjunction with his earlier chapter on turbulent flow, this chapter justifies Dr. Sutton's statement that there has been much energy spent and ingenuity exercised in investigating problems of wind structure. Has it been overdone? The author's reply would doubtless be to ask the questioner to re-read his final chapter to find there how all that has gone before

can be used in solving problems of dispersal of smoke and other forms of atmospheric pollution, and in providing complete, if complex, expressions for evaporation-rates from open water. These expressions would have much greater practical value if they were accompanied by short tables giving a range of values of the stability-dependent constants that appear in equations 8·55, 8·56 and elsewhere: not everyone who will want to use this chapter will possess tables of incomplete gamma functions or know where to find them.

For a summary impression of the book as a whole we can go back to its beginning. It is dedicated to Sir David Brunt: it is a worthy offering.

H. L. Penman

SELECTIONS FROM THE WORKS OF C. G. JUNG

Psychological Reflections

An Anthology of the Writings of C. G. Jung. Selected and edited by Jolande Jacobi. Pp. xxvii+342. (London: Routledge and Kegan Paul, Ltd., 1953.) 30*s*. net.

THIS anthology of Jung's writings, compiled by Dr. J. Jacobi, is a bedside book: "The object is to show by means of a cross-section a few of the more important aspects of existence reflected in humanity in general, when understood and illuminated by Jung's Psychology. It was not the intention to present Jung's theory; therefore everything which is technical has been excluded".

The publishers recommend this book "not only for the use of scientists, but for all who want to arrive at a better knowledge of themselves and the world". They are presupposing that there is a discovery to be made which is not only scientific discovery—discovery by observation and deduction therefrom in strict accordance with logical rules—but also a discovery by reflexion, a moral discovery.

The whole work of Jung as a man of science poses the question of validation. If the basis of science turns out to be 'unscientific' and 'facts' are as indeterminate as any symbolic experience, then we have to admit that Prof. C. A. Coulson is right when he states that facts say nothing at all; what matters about truth is not the facts, but the interpretation of the facts.

Just as, in physical science, concepts like atoms and electrons are logically unobservable but are validated by analogy, so it is with the working of the mind. What are being experienced there are not fixed things but reflexions of experiences which manifest themselves in symbolical terms. Man to-day, however, is conditioned by his 'scientific' training to think quantitatively and forgets that validation is experienced also in image thinking. Verbal thinking and image thinking go side by side, and Prof. H. H. Price says in his book, "Thinking and Experience" (p. 252): "If rainbows, reflections, mirages and the like had been less common than they are, philosophers would have denied their existence on *a priori* grounds. For how can there be entities which are at once physical and non-physical, in the physical world and yet not of it, existing from some points of view and not from others, spatial but lacking backs or insides? The fate of mental images, in these latter Verbalistic days, has been somewhat similar. We have the misfortune to live in the most word-ridden civilization in history where thousands and tens of thousands spend their entire working lives in nothing but the manipulation of words. The whole of our higher education is directed to the encouragement of verbal thinking. Let us hope that our successors will be wiser, and will encourage both".

It is with image thinking that Jung's work is concerned. Those who are not too much bogged down in verbal logic, and thus able to experience that there is active also a process of imaging in man's faculties of cognition, will be able to appreciate the significance of this book. The anthology is a useful introduction to the rest of Jung's work. It shows clearly the fundamental weakness of Jung's psychology, which by having no fixed scheme appears to be full of contradictions and paradoxes; but this weakness is at the same time a sign of its greatness. For, life in the psyche manifests itself thus: "You cannot step twice into the same river, because fresh waters are ever flowing in upon you".

H. Westmann

THE PROGRESS OF PLANT PHYSIOLOGY

Annual Review of Plant Physiology

Vol. 4. Daniel I. Arnon (Editor). Leonard Machlis (Associate Editor). Pp. x+453. (Stanford, Calif.: Annual Reviews Inc., 1953.) 6 dollars.

NOTHING could emphasize more strikingly the rapidity of the growth in knowledge of the physiology of plants than the "Annual Reviews of Plant Physiology" published under the general editorship of Dr. D. I. Arnon and Dr. L. Machlis. No longer can the plant physiologist, by the reading of original papers only, hope to keep up to date with all the aspects of his subject, and all students and teachers of plant physiology should feel grateful to the editors, contributors and publishers of these reviews for making it possible for the generality of plant physiologists to obtain a reasonable appreciation of the work done in those branches of the subject outside their own specialist interests. Each annual volume, four of which have appeared at the time of writing, does not attempt to cover the whole field of plant physiology, but contains a number of reviews, fifteen in each of Volumes 3 and 4, written by authorities in their respective fields, of a limited number of particular aspects of the science, those which are undergoing rapid development being dealt with more frequently than those which are attracting less attention as current subjects of research. Thus, photosynthesis was dealt with in 1952 by E. Rabinowitch, while in the 1953 volume it is reviewed by A. H. Brown and A. W. Frenkel and reviews on certain aspects of photosynthesis by D. Burk and L. R. Blinks are promised for 1954. On the other hand, a number of topics such as the physiology of root growth, the biogenesis of terpenes, the plant sterols and fluorescent substances in plants by H. Burström, A. J. Haagen-Smit, W. Bergmann and R. H. Goodwin respectively are reviewed in the 1953 volume but are not in the list of subjects for 1952 or 1954. This policy would appear to be a wise one, for it has the result that each branch of the subject considered contains enough material for an article of reasonable length the writing and reading of which are worth while.

Among articles in the 1953 volume dealing with plant metabolism, apart from those already mentioned, is one by J. G. Wood on the nitrogen metabolism of higher plants in which recent work on the path of nitrate reduction and protein synthesis in plants is adequately summarized. Another aspect of plant metabolism attracting much interest at the present time, namely, the part played by organic acids in metabolism, is ably reviewed by R. H. Burris, while the important question of the use of respiratory inhibitors is exhaustively dealt with by W. O. James, who refers to no less than 247 contributions bearing on this subject. A valuable review on hæmatin compounds in plants is the work of R. Hill and E. F. Hartree. This includes an account of the distribution of hæmatin compounds in plants with some remarks on the possible part played by these substances in photosynthesis, a discussion on the cytochrome system as a terminal oxidase in plant respiration, the role of this same system in salt respiration, the function of hæmoglobin in the root nodules of the Leguminosæ, and an account of recent work on catalase and peroxidase.

Reviews concerned with the popular topics of growth substances and herbicides are contributed by H. Veldstra and A. S. Crafts respectively, while the physiology of fruit growth, a subject about which not a great deal is known, is dealt with in a stimulating review by J. P. Nitsch.

The remaining reviews which make up the 1953 volume are on the physiology of mycorrhizal relations in plants by E. Melin, the effect of temperature on plant growth by F. W. Went and the physical properties of protoplasm by H. I. Virgin.

The enormous amount of literature reviewed in a single volume and the high standard maintained generally by the various contributors make these annual reviews a most valuable addition to the literature of plant physiology. They are, indeed, a necessity to the plant physiologist who means to keep abreast of advance in knowledge of his subject.

W. Stiles

RECENT ADVANCES IN SPELEOLOGY

British Caving

An Introduction to Speleology. Edited by C. H. D. Cullingford. Pp. xvi+468+48 plates. (London: Routledge and Kegan Paul, Ltd., 1953.) 35*s*. net.

THE publication of this book marks a conspicuous advance in the study of British caves and shows that modern cave exploration must be regarded as something more than a 'sport'. Hitherto, much material of scientific value about limestone caves has remained either unpublished or hidden away in the little-known journals of local caving clubs. The collection of this scattered information, together with an introduction to the many problems with which caving is concerned, has now been attempted by fifteen members of the Cave Research Group. This Group was formed in 1947 to further "the study of all scientific aspects of cave exploration"; "British Caving" is the Group's first major publication, and is also the first book to cover comprehensively the chief aspects of British caves and caving. Its aim is twofold; first, to give an account of the recent work on caves and the advances in caving techniques; secondly, to provide, for the rapidly growing numbers of cave explorers, with little or no scientific training, both a guide to the organization of caving and to scientific methods of observation.

The book is divided into two parts. Part I is the larger and is called the "Science of Caving". In this part, Dr. Warwick summarizes the many problems connected with the origin of limestone caves and with the relationship of the caves to the surface land-forms; he also contributes a chapter on the main characteristics of the caving regions of the British Isles. Dr. Wilfred Jackson's contribution is a detailed account of the British caves from which archæological remains have been obtained; its value is mainly bibliographical and the chapter contains an extremely useful list of the museums where the various 'cave finds' can now be examined. Miss Hazelton and A. E. Glennie have written a section on how to observe and to collect cave fauna and flora; a comprehensive list of the fauna and flora so far recorded from caves in the British Isles is also included. A fascinating chapter, illustrated by a series of fine photographs taken by J. D. H. Hooper, describes the studies now being made in south Devon on cave-dwelling bats. Chapter 7 briefly mentions certain physical aspects, such as air currents and temperatures, the tracing of water-flow under groundand geophysical methods of locating caves. Finally, there is a chapter on the caves associated with lead mines; this is, however, rather slight and is in many ways not up to the general scientific standard of this part of the book.

Part 2 deals with the "Practice of Caving". There is a short note on the history of cave exploration and this is followed by discussions of the equipment and of the procedure and safety precautions necessary in any cave investigation. The chapter, by F. G. Balcombe, on the history and work of the Cave Diving Group is one of the most exciting stories to be told in modern caving. Part 2 also contains clearly written instructions and suggestions on cave photography and on cave surveying. An appendix gives a list of the caving organizations in the British Isles and a glossary of some of the terms used in connexion with caves and limestone areas.

The book is very readable, though as might be expected in a compilation there is considerable unevenness in the treatment of the different topics, and occasionally an incongruous mixture of styles. Moreover, the book covers a field so wide that unavoidably many geological and other problems have to be over-simplified. Full bibliographies at the end of each chapter partly overcome this defect. Many of these bibliographies would be of greater use if they were more selective; since, also, the literature about caves is of very varying quality, annotation would help the beginner both to acquire the basic scientific knowledge and to discriminate between the useful and less useful references. The reviewer also regrets the substitution of the American words *vadose* (above the water-table) and *phreatic* (below the water-table) for the English terms long in use by British geologists.

"British Caving" is well printed and produced and contains about eighty photographs and many clearly drawn maps and diagrams. The book is indeed a tribute to the amount of solid work put in by the Group; it should introduce many, as its writers hope, to the wonders of limestone caverns, but what is probably more important is that it should establish speleology as a well-defined branch of modern natural history.

M. M. Sweeting

THE EXPERIMENTAL STUDY OF SPEECH*

By Dr. D. B. FRY
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THE speech process consists of a series of transformations, from the stage of the linguistic memory through nervous and muscular activity to that of variations of air pressure and then back again. The purpose of the experimental investigation of speech can be summarized as the study of these transformations, the establishing of correlations between events at each succeeding stage, and the examining of the form of these correlations.

In recent years, the study of speech has been influenced by new points of view and by the development of new experimental methods for exploring the correlations between the linguistic, the physiological and the physical aspects of speech. Experimental research by its very nature imposes an operational view of the subject-matter to be examined, and the adoption of such a view of speech might at first appear to preclude work on certain of the linguistic aspects of speech such as 'meaning'. It is quite possible, however, to explore experimentally the associations of words and other linguistic units for different individuals. Lenneberg[1] has done some research, for example, on the associations of words for colours. He presented a number of subjects with a great variety of different colours, varying the hue and the brightness in a systematic way, and then correlated the words used by the subjects to denote the colours with the variation in the stimulus. In these experiments there is a very obvious physiological component; subjects who have some degree or type of colour blindness are likely to have fewer associations in common with the rest of the population, though they may show a good deal of agreement among themselves. The results in general showed that the degree of agreement between individuals varied as the stimulus was changed: there were a number of points of maximum agreement, at some of which the subjects were unanimous in their choice of a word—thus for some particular colour everyone used the word 'red'; then as the stimulus was changed in a given direction, gradually a greater diversity of words was used. In addition to this general pattern of agreement, it was possible to see fairly systematic variations of association according to the background of the individuals.

What is usually referred to as the meaning of a term is therefore from this point of view the total of the associations held in common by the majority of the users of the term. Experimental work based on this point of view is naturally most easily carried out on the associations of concrete words. Although the extent of the linguistic material that can be explored in this way is obviously limited, the results do shed some light on the way in which this part of the speech process works, and by the use of such methods the semantic factor in speech can be brought within the range of experimental work.

Another important feature of the linguistic aspect is the influence of context. At the phonemic level, the effect of context is generally viewed nowadays in terms of communication theory. Shannon's conclusions about the statistical structure of written English[2] are applicable to the sound system of a language. The experiment in which he asked a subject to guess the sequence of letters in an English sentence can be repeated with the sounds of spoken English, provided the subject has had enough phonetic training to think in terms of sounds rather than letters. The technique is to choose a sequence of English sounds forming a sentence and then to ask the subject to guess each successive sound. The number of guesses required to arrive at the correct sound shows considerable variation. At the first position the number is high, and it shows in general a gradual decrease as the sequence proceeds; within this general trend, there are smaller rises and falls at succeeding points in the sequence, the peaks of uncertainty usually falling at or near word or syllable junctions. These results have encouraged several workers to explore the usefulness of distributional criteria as a basis for defining linguistic units[3].

In investigating the function of the nerve connexions in speech, a valuable step forward has resulted from the study of feed-back mechanisms and the part that they play in the speech process. The methods used depend in every case on some interference with the feed-back—interference which may be temporary and artificial, or the result of a pathological condition and more or less permanent. For example, the case of the congenitally deaf child is more clearly understood, since the enormous importance of the auditory feed-back for speech has been appreciated. The training of such children is seen to require first and foremost the provision of any degree of auditory feed-back that is possible for the particular child, and then the supplementing of this by the use of visual, tactile and kinæsthetic feed-back.

The methods of interfering artificially with the feed-back circuits have been concerned with the auditory feed-back, and have consisted in either obliterating the feed-back altogether, or in delaying it. This interference is possible because, when we sing or speak, most of the sound which we ourselves hear is conveyed to our ears by bone conduction. The bone-conducted sound can be completely masked by supplying to the ear some other sound of sufficient intensity by air conduction; the latter may be a very loud masking noise, which obliterates the auditory feed-back altogether, or it may be the subject's own speech (or singing) delayed by some time interval. One of the effects of obliterating the feed-back altogether, for example, is that the mechanism which controls the pitch of the singing voice no longer functions properly and the subject can no longer sing in tune. When the feed-back is delayed, the effect upon speech is very dramatic. It appears that the speech mechanism is very sensitive to delay in the auditory feed-back, at least over a certain range of delay times. The effect produced varies with individuals and with the delay time; but it generally takes the form of an artificial stammer, and the speaker in this condition feels himself under considerable nervous stress.

* Substance of a lecture delivered in University College, London, on March 16.

Experimental evidence about the functioning of muscular systems has been obtained in recent years largely by means of photographic methods. The change from muscular movements to wave motions in air is one which we should expect to yield a close correlation between the two sets of events, and for this reason many attempts have been made to obtain a more exact record of these movements both at the level of the larynx, which may be regarded as the primary generator of the wave trains of speech, and also at the level of the articulatory mechanism which modifies the output of the larynx. High-speed direct photography has been applied to the study of the functioning of the larynx at the Bell Telephone Laboratories, where for the first time some of the modes of vibration of the vocal cords have been recorded; this work has provided evidence of the relative times of the open and closed phase of the cords, which are seen to vary with individual speakers and with the fundamental frequency of the vibration. This matter is of considerable importance to any attempt to calculate the physical output of the speech mechanism from a consideration of its physiological and anatomical properties. Still further evidence about laryngeal functioning has resulted from the improved X-ray photographic techniques which are now available. The internal action of the larynx was for a long time inaccessible to X-ray photography, but the development of the tomogram technique has enabled Ardran and Kemp[4] to obtain remarkable records of the larynx in action. The evidence which they offer concerning the sphincteric action of the larynx may well lead to a reconsideration of the way in which this part of the speech mechanism functions.

Photographic methods, both direct and X-ray, have been applied also to the examination of the articulatory mechanism. Films have been taken of subjects in whom some abnormal anatomical condition allows a direct view of parts of the speech mechanism. The first of these, made in 1943 [5], showed the movements of the tongue in the speech of an English subject whose right cheek had been removed surgically. In a more recent film of a similar nature, it is possible to see from above the changes in the disposition of the soft palate during speech. All such records are open to objection on the grounds of the abnormality of the subject, both from the point of view of anatomy and of the acoustic output of his speech mechanism. On the other hand, there is a strong argument for attributing some degree of normality to the movements which we see, since we know that it is very difficult for the adult human being to change his speech movements, a fact which is brought home afresh to anyone who tries to learn to speak a new foreign language.

The physical aspect of speech is much more accessible to experimental study than the linguistic and physiological aspects, and it is possible to give a very full description in physical terms of the wave motions of speech. The difficulty consists in establishing the correlations between features of the wave-motions and the perception and understanding of speech by the listener. The classic view of the problem was that speech sounds consisted, physically, of a more or less rapidly changing complex of frequencies, among which a few high-amplitude components, called the 'formants', were responsible for the discrimination of different sounds by the listener. Hence the most favoured method of examining the speech wave-motions was by a process of frequency analysis which would lead to the detection of the formants. A system which is particularly adapted to this purpose is the one which was at first labelled 'visible speech'. This was developed by the Bell Telephone Laboratories[6] during the war years and is essentially a conventional system of frequency analysis; its new feature is the provision for presenting the analysis extended along the time axis. The output of the system generally takes the form of visual patterns, known as 'spectrograms', in which time is represented on the horizontal axis, frequency on the vertical axis, and the relative intensity of the frequency components is indicated by the gradation from black to white in the pattern.

Many people have, in recent years, come to the conclusion that frequency analysis, in its classical form, is not the real basis for recognition, and have sought to develop other methods of inspecting the speech wave-motions. It has been suggested, for example, that the discrimination of sounds might depend on the perception of differences in the frequency with which the wave-form crosses the zero line, and that all speech sounds might be recognized on this basis. It is possible by electronic circuits to transform the speech waves in such a way that each zero-crossing is represented simply by a pulse, and these pulses can be counted electronically in order to arrive at the frequency of zero-crossings for given unit times. The first important result obtained by this method[7] was the demonstration that if the pulses themselves were simply transformed into acoustic wave-motions, they constituted sounds which were perfectly intelligible as speech to the ordinary listener, thus showing yet again that speech is extremely resistant to a great variety of distortions. In addition to this, many experiments have been made in which the zero-crossings have been, so to speak, re-arranged: they have been averaged over various time-intervals; they have been spread out and condensed along the time axis; the negative-going pulses have been omitted altogether and have also been replaced by positive-going pulses with very interesting results; the form of the variation in zero-crossing frequency for different speech sounds has been closely examined. The results of many of these experiments have not yet been published; but up to the present there appears to be no very strong evidence that any method of treating the zero-crossings yields results showing an appreciably closer correlation with the linguistic units than the results of more conventional systems of frequency analysis.

All these ways of inspecting the speech wave-motions aim at discovering the perceptual–physical correlations by transforming the wave-motions in a variety of ways in the hope of finding one method which will give the desired correlations. An alternative to this method is the use of a speech synthesizer, a machine which will generate speech-like sounds of a relatively simple physical nature and by means of which the effect of single physical clues to the primary recognition of sounds may be explored. A number of such synthesizers are now in use and many interesting results have already been published. Liberman, Delattre and Cooper[8], using a synthesizer which produces sounds from simplified spectrograms, have shown that a short burst of sound lasting about 15 m.sec. and covering a narrow frequency-band will be recognized as a consonant of the plosive type when it is combined with a vowel-like sound. In one series of experiments, the location of this burst on the frequency-scale was taken as the

single physical clue, and it was found that listeners judged the consonant to be *p*, *t* or *k*, depending on the position of the burst and on the vowel with which it was combined. A second series of experiments was concerned with another clue which appears to be important for the primary recognition of consonants[9]. This is the 'formant transition'—the way in which the frequency of a formant changes in the course of a syllable. Synthesized sounds consisting of two formants the frequency of which remained constant throughout were recognized by listeners as single vowels; if, however, the formant frequency was changed fairly rapidly during the first 50 m.sec., the listener heard the vowel preceded by a voiced plosive consonant. The direction of the frequency-change, its extent and the particular vowel sound concerned, all combined to determine whether this consonant was *b*, *d* or *g*.

In further experiments with the same synthesizer, Denes[10] demonstrated the importance of time-relations for the primary recognition of speech sounds. Listeners judged a fricative sound to be either *s* or *z* according to the ratio of its duration to that of a preceding vowel. When the fricative was short compared with the vowel, the majority of subjects heard *z*; and these judgments changed in favour of *s* as the friction was made progressively longer compared with the vowel.

Time relations were again shown to be an effective clue for recognition by work which I have carried out[11]. The object of these experiments was to test the effect of the ratio of durations and of intensities as clues for discriminating between stressed and unstressed syllables in English. The material used for this study was a group of words like 'object' in which, for most speakers, a change of function from noun to verb is accompanied by a shift of the stress from the first to the second syllable. Many different versions of each word were synthesized in which the ratios of durations and of intensities of the two vowels were varied over a considerable range. Listeners were then asked to say whether they recognized the noun or the verb form in each case. The results of this test showed that both duration and intensity operated as clues for recognition, but that the duration clue was much the more effective. The whole range of intensity-changes was responsible for a change of only 27 per cent in listeners' judgments, whereas the range of duration changes produced a change of 71 per cent.

This experimental procedure, which makes it possible to examine the operation of physical clues separately, has already done a great deal to make clearer the general nature of the recognition process, and to suggest the terms in which it may be possible in the future to state the very complex correlations that exist between the perceptual and the physical in speech.

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GOETHE'S SCIENTIFIC BACKGROUND

IT has been said that, whereas we know next to nothing about Shakespeare's life, almost too much is known about Goethe's. His autobiography, diaries, correspondence, carefully recorded talks, and innumerable scattered notes which were never meant for publication, provide such an inexhaustible wealth of material that any exegete intent on emphasizing a special tendency in Goethe's mind could produce some evidence for his thesis if he is willing to spend enough time on the perusal of every available source.

A recent book by Dr. Ronald D. Gray on "Goethe the Alchemist"* sets out to show "that Goethe was profoundly influenced throughout his life by the religious and philosophical beliefs he derived from his early study of Alchemy". It is a very learned book, so rich in not easily accessible material that admirers of Goethe will study it with pleasure and profit, even though they may be unable to agree with the author's opinion.

Goethe's interest in alchemy is well known to every reader of "Faust"; it may even be correct to say that all that the average educated German knows about alchemical imagery is contained in the few very colourful and impressive lines in which Faust describes the laboratory experiments of his deceased father. From the second part of "Faust", many will remember also the alchemical origin of Homunculus. It is certainly a merit of the author to have searched with enormous industry for further alchemical ideas and symbols not only in Goethe's lesser-known poetical works but also in his scientific writings, and much of what he has to say about alchemical reminiscences in Goethe's "Farbenlehre", his "Metamorphose der Pflanzen", and his anatomical, geological and meteorological papers, will strike the reader as worth pondering about; but it is usually far from convincing.

A great deal has been written about Goethe's strange theory of the origin of coloured light and his stubborn refusal to listen to any German defender of Newton's explanation. To Goethe, his theory of colours was much more than the solution of an isolated problem in physics; it was, as has been shown by many writers, intimately connected with his personal way of searching for explanations of natural phenomena; but whether we can see in his colour-theory as close a connexion with alchemy as Dr. Gray suggests is quite a different question. He wants to make us believe that the empirical appearance of Goethe's colour-theory is only "superficial" and that, first of all, it had to conform with alchemical doctrines, with the colour changes described by alchemists as essential for their 'Great Work'. Considering the small number of the six or seven rainbow colours mentioned in alchemical writings, occasional similarities with Goethe's statements will not surprise us—all the less, since the alchemists, like Goethe, were starting from actual observations, and many of them were by no means so completely lost in symbolism as readers of some recent books, for example, those by C. G. Jung, may believe. The influence on Dr. Gray of Jung's re-interpretation of alchemy is very obvious, and he goes even further in the same direction in his attempt to show that in Goethe's

* Goethe the Alchemist: A Study of Alchemical Symbolism in Goethe's Literary and Scientific Works. By Ronald D. Gray. Pp. x+312+3 plates. (Cambridge: At the University Press, 1952.) 35*s.* net.

theory of colours, too, not the experimental content but the symbolism is essential; but it is almost inconceivable that anyone could get such an impression who studies Goethe's work without a preconceived idea. With infinite patience experiment after experiment was described by Goethe, and the reader exhorted to repeat and check them; this has been done by many who have realized with admiration that Goethe, whose colour sense must have been of a very high order, was not only extremely accurate in his descriptions but was also sometimes even the first to notice some delicate phenomenon. To the countless experiments and historical studies connected with his theory of colours, Goethe devoted probably more effort than to any other single work.

Goethe himself was very careful to draw a clear line between the scientific part of his theory, which he was confident could by experiments be demonstrated to be superior to Newton's, and the entirely different concluding section on "the sensorial and moral effect of colour" ("Sinnlich-sittliche Wirkung der Farbe"). This subject is naturally quite different; here Goethe the artist is speaking, and it is very unfortunate that without warning to his readers Dr. Gray mixes the quotations from both parts. Right at the end of this last section, one or two pages are devoted to the "Allegorical, symbolical and mystical use of colours". Here Goethe declares that he did not want to be suspected of mysticism ("Schwärmerei") and predicts that, according to the fashion of his days, there would anyhow be no lack of allegorical, symbolical and mystical applications of his theory. This remark is no encouragement for such attempts, and Goethe did not foresee that he might have to fear even an alchemical interpretation, such as presented now in Dr. Gray's book. As "final evidence" for his thesis, Dr. Gray quotes a passage in which an old anonymous writer says that his remarks about colours "can be combined with the secret philosophy and experience of the chemists", a passage republished by Goethe in one of his occasional minor writings; we are told that this is "the frankest declaration on Goethe's part of the fact that his Colour-Theory was only to be fully understood in terms of alchemical symbolism". If that is the frankest, our doubts are scarcely dispelled as to whether the author is on the right track, or whether he is perhaps deluding himself when he believes he notices everywhere in Goethe's theory of colours the smell of alchemy.

Discussing the meteorological images in Goethe's poetry, Dr. Gray quotes a passage from the final scene of "Faust II" where clouds change into a host of blessed spirits. "The immediate source of this image can be traced back to a moment of Goethe's life some fifty years before those lines were written" —so we are told, and a remark is quoted from a letter written in the far-distant days when alchemy was still near to Goethe's heart. Now for the modern author, who has all Goethe's works simultaneously available, this source may appear "immediate"; but for Goethe himself a letter written to a friend fifty years earlier can scarcely have been an immediate source, nor is it likely that just one, not at all unusual, observation of so long ago was still present in his memory.

It is not to be expected either that the alchemical explanation of the *Urpflanze*, to which Dr. Gray devotes much space, will convey conviction to many. We are informed that the stages of this hypothetical plant correspond to Boehme's "Seven Qualities of God", and in some of the stages no doubt resemblances can be found; but it is only "by ignoring Goethe's definite statement that there are six stages in the life of the plant, and including what he omitted, the original seed" that it was possible for the author to establish "a very close parallel with mystical doctrines". Here again we meet the usual trouble: Goethe was careful "to publish only the barest hints. The passages which most reveal his thoughts are found almost entirely in his private notes or in later publications".

It must be conceded to Dr. Gray that, although it was his professed task to go so far as possible in an attempt to follow up in Goethe's works alchemical influences, he nevertheless sometimes shows restraint, when we are already fearing the worst. We are certainly grateful to him that, after drawing "Iphigenie" into a chapter on Amazons, hermaphrodites and the symbolism of the "male and female" in alchemical writings, he assures us that in spite of "the union of opposites, sun and moon, brother and sister", which provides a happy conclusion of the play, "it would be absurd to claim Iphigenie as an example of Goethe's use of alchemical symbolism". Mignon is not so fortunate; she is plainly called a hermaphrodite, although Dr. Gray admits that she is not quite so perfect a being as this—in alchemical parlance—very laudatory expression indicates. On the other hand, one feels again relieved when the sentence "it would make for a neat interpretative pattern if one could agree with C. G. Jung that the whole of Faust II is a poetic representation of the alchemical work", is followed by a "but"; one would wish, however, that here the author's objection was not confined to the lack of alchemical symbolism in the third act of "Faust II", but that he would say in so many words how pointless the whole "Faust II" would appear to most of us if Goethe's ambition had really been what Jung supposes; we should be inclined to say, in Mephisto's words, "ein grosser Aufwand, schmählich, ist vertan".

Dr. Gray is so convinced that the expressions Goethe uses in the description of natural phenomena must come from the writings of the alchemists, that he assumes such a parallel even if he has no proof at all to offer. Goethe believed that the crystallization of rocks was accompanied by a tremor; the author admits that here the parallels with alchemical literature "are not as close as one could wish", but he "feels" that some of the alchemists "also must have used such expressions" for their process, although he has "not chanced to come across any such passages". Why should we look for such a distant and purely hypothetical source of Goethe's views if (in a paragraph quoted in the present book) he refers to the simple observation that "water in a vessel, on the point of freezing, is transformed by the slightest shock into solid ice"? Let us not forget that if Goethe was anything in science, he was a brilliant observer. For a similar reason, there can be no necessity at all for assuming that, when Goethe likened little clouds to white doves, these birds must have been reminiscences of alchemical symbols he had come across in his youth, and that only "later he came to feel that Nature herself offered such symbols in plenty". After all, he was a poet too.

It is to be hoped that no reader of this book will forget that its aim is to bring out certain aspects of Goethe's *Weltanschauung* by sharply illuminating them from a certain angle, and that by this process other features are necessarily obscured. The study

of "Goethe the Alchemist" should be followed by the reading of books with titles like "Goethe the Classicist", "Goethe the Spinozist" and, most necessarily, "Goethe the Scientist". The author himself is helpful here in providing a list of "Books and Articles consulted", which comprises, in the section entitled "Goethe's Science", some fifty authors. Three very valuable contributions to the subject are, however, missing: Helmholtz's and Tyndall's well-known studies on Goethe's scientific work and—less astonishing, but still more regrettable—C. G. Carus's little book "Goethe" (Leipzig, 1843). For anyone who has ploughed his way through the complicated symbolism attributed to Goethe in Dr. Gray's book, it will be most refreshing and clarifying to read Carus's chapter on "Goethe's Relation to Nature and Science". Discussing his various contributions to science, Carus gives pride of place to the idea of the *Urpflanze* which had been "of the highest and most enlivening effect on the whole field of botany". (Similar praise is bestowed on his anatomical ideas.) Is it likely that a revival of Boehme's and other alchemists' and mystics' abstruse ideas, "a cunning and intricate pattern of metaphor and simile, elaborated down to the smallest detail"—as Dr. Gray calls Goethe's botanical theory—could have had such a beneficial influence on the progress of modern science? I believe it to be very significant that neither in this chapter, nor in the one which attempts to explain Goethe's works "from an understanding of his personality", are alchemical interests mentioned by Carus even once. He must be considered as one of the most competent judges, as he knew Goethe personally, enjoyed his affection and respect as shown in their correspondence and had many scientific and artistic interests in common with Goethe, being himself eminent in such various fields as anatomy, psychology, philosophy and painting. If Carus, in his explanation of Goethe's scientific background, could leave out alchemy completely, one's suspicion is strengthened that Dr. Gray's point of view is only the purely literary and utterly non-scientific attitude of a late interpreter, and that it is the arbitrary emphasis which he lays on a few of the remotest of Goethe's utterances that makes the alchemical influence appear of such over-riding importance.

We are nevertheless indebted to Dr. Gray for having spent so great an effort on the pursuit of this single line of research, and for having collected the scattered material in a very original book.

F. A. Paneth

VERTEBRATES WITHOUT ERYTHROCYTES AND BLOOD PIGMENT

By Prof. JOHAN T. RUUD
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It is frequently claimed that one of the characteristics of vertebrates is that they have a red blood pigment, hæmoglobin. Exceptions are the *Leptocephalus*-larva of the eel, which has no blood pigment until it develops into an elver, and *Petromyzon*, which has a blood pigment slightly different from that of other vertebrates.

For half a century, however, whalers in South Georgia have known that there are three local species of fish, namely, *Champsocephalus gunnari* Lönnberg, *Pseudochaenichthys georgianus* Norman, and *Chaenocephalus aceratus* (Lönnberg), all of which have a colourless blood. The Norwegian whalers call them "bloodless fish" (*blodlaus-fisk*).

I first heard about these "bloodless fish" on a visit to South Georgia in 1929; but no specimens were forthcoming, and I did not take them seriously. I was reminded about their existence, however, when Mr. D. Rustad, biologist in the *Norvegia* Expedition (1927–28), presented me with some photographs of a "white crocodile fish" caught by him at Bouvet Island, mentioning the fact that its blood was colourless. From these photographs Nybelin[1] in 1947 described the fish as a new species, *Chaenocephalus bouvetensis*, believing it to be distinct from *C. aceratus* known from South Georgia and other west Antarctic islands. Nybelin cites the description communicated to him by Rustad, in which we find the remark: "Blood colourless". Farther on he says about the South Georgia species that it "is said to have colourless blood" (ref. 1, p. 51). So far as I know, this is the first time the fact is mentioned in the literature. (After this was written my attention was directed to a book by L. Harrison Matthews, "South Georgia, the British Empire's Subantarctic Outpost", published in 1931, in which the author on p. 36 mentions the fact that a species of fish with white gills and colourless blood exists in South Georgia.)

I heard about colourless blood in fish again when Mr. Fredrik Beyer, biologist in the Norwegian *Brategg* expedition (1947–48), returned home with some specimens of *Champsocephalus esox* (Günther) taken by him in the harbour of Punta Arenas. In his paper on the fishes from this expedition, Nybelin cites Beyer's description: "The gills colourless on the living animal" (ref. 2, pp. 9–10).

When Mr. Steinar Olsen was sent to South Georgia to conduct some investigations on the "South Georgia cod" *Notothenia rossi marmorata* Fischer, I asked him to look out for the fishes with colourless blood, and he returned in 1951 with some preserved specimens of the fishes and samples of their blood frozen and fixed in formalin.

Prof. P. A. Owren (Medisinsk Avd. A., Rikshospitalet, Oslo) prepared blood smears from these samples and stained with May Grünwald and Giemsa. He found no cells resembling erythrocytes; but a few nucleated cells, presumably lymphocytes, were present. No blood pigment could be demonstrated in these samples, and their fixed condition prohibited a closer study of the blood proteins.

In December 1953, after the whalecatcher *Enern* had completed her international whale-marking voyage at South Georgia, I was able to make some determinations of the oxygen capacity of the colourless fish blood. Steinar Olsen had told me that in the Antarctic midsummer I could expect to catch only one of the three species known to occur in South Georgia, namely, *Chaenocephalus aceratus*, known to Norwegian whalers as the "white crocodile fish" and to British whalers as the "icefish", probably because it is nearly transparent.

Indeed, I would not have succeeded in catching this species either, were it not for the unfailing help of Mr. Sigvald Sørensen, storekeeper at Husvik Harbour, and of Dr. D. Felix Richards, physician at Leith Harbour. I am indebted to the managers of both whaling stations, Mr. Nils E. Olsen, of Husvik, and Mr. S. L. Bjelland, of Leith, for facilities liberally placed at my disposal.

The oxygen capacity of the blood was determined by the micro-gasometric method described by Roughton and Scholander[3], with certain modifications necessary for working on fish blood, kindly communicated to me by Dr. Scholander just before my departure from Norway.

I secured four specimens of *Chaenocephalus aceratus* in all, the first three shortly after my arrival to South Georgia and before I was fully prepared to make the analyses. My first analysis was made, therefore, on blood which had been stored for some days in a refrigerator. Later I obtained the fourth specimen and could repeat all observations on freshly drawn blood, taken from the ventricle of the heart with a syringe in which the dead-space had been filled with heparin to prevent clotting.

The freshly drawn blood is nearly transparent, with a slight yellowish-white tint. Without the addition of some anticoagulant it clots in the course of two or three minutes to the consistency of a soft jelly.

After being centrifuged for 30 min. at 3,500 rev./min., the plasma is clear as water, and the sediment of white cells constitutes less than 1 per cent of the volume.

No absorption band can be discerned in a spectrum.

Blood smears stained with May Grünwald and Giemsa confirmed the previous observations, that there are no blood corpuscles similar to the erythrocytes of normal vertebrate blood.

Before determining the oxygen capacity, the blood was aerated for 15–50 min. in a container open to the air and revolving slowly around a horizontal axis.

The blood from the first three fish had been mixed and kept in a refrigerator for five days before the oxygen capacity was determined. The colour of this blood seemed to be unchanged and it smelt good, but a little 'fishy'. Four determinations gave an average of 0·67 per cent by volume of oxygen in the range 1·08–0·45.

The average of eight analyses of the freshly drawn blood from the fourth specimen gave 0·72 per cent oxygen by volume (range 0·90–0·54). What was left over from this sample was used as a check on the earlier determinations by keeping it in a refrigerator for five days and then making three further analyses. These gave an average of 0·77 per cent oxygen by volume (range 0·945–0·675), which is slightly more than on the first occasion.

For comparison I determined the oxygen capacity of normal red blood from two other local species of fish, *Notothenia rossi marmorata* Fischer and *Notothenia coriiceps* Richardson. They gave mean values of 5·99 and 6·24 per cent by volume of oxygen, respectively, capacities of the same order as those known from northern fishes.

The oxygen capacity of the blood of *Chaenocephalus aceratus* is presumably not more than what one would expect to find in the plasma alone of ordinary red blood. It seems evident, therefore, that *Chaenocephalus aceratus* has no means of taking up oxygen in its blood except by physical solution.

A small sample of the blood was taken back to Norway stored in a refrigerator. From this sample, which was now slightly decomposed, Dr. Ernst Føyn, of this Laboratory, has determined the iron content according to the method described by Wong[4]. He found less than 1 mgm. per cent iron. This result cannot claim to give the true value of the iron content of the blood of *Chaenocephalus aceratus*, since the sample had a minute addition of heparin.

Van Dam and Scholander[5] and others have determined the iron content of the red blood of various species of fish and give mean values of 19·6–26·7 mgm. per cent. The result of Dr. Føyn's analysis supports, therefore, the view that the blood of *Chaenocephalus aceratus* is to be considered as a plasma with a moderate content of leucocytes.

I had no opportunity of determining the actual metabolism of *Chaenocephalus aceratus*. One would expect it to be rather low, and the fish seen alive gave the impression of being quite sluggish compared with other species taken at the same time. It seemed to be very sensitive to lack of oxygen, because as soon as it was landed it made laboured respiratory movements, extending its gill-covers as widely as possible, thus displaying the peculiar yellowish-white colour of the gills. I did not measure the respiratory surface of the gills; but they seemed to be relatively big. Such measurements will be made on the preserved specimens.

It should be noted that *Chaenocephalus aceratus* attains to 60 cm. or more and can weigh more than 1 kgm. The two other 'bloodless' species known from South Georgia are slightly smaller, *Champsocephalus gunnari* being about 32 cm. long and *Pseudochaenichthys georgianus* about 48 cm.

All three species belong to the family Chaenichthyidae, the characters of which include a naked body and ribs not ossified. According to Norman[6], the family has nine genera with thirteen species, to which belong the species described by Nybelin from Bouvet Island. Thus thirteen are confined to the Antarctic zone. Only one species is found north of the Antarctic Convergence, namely, *Champsocephalus esox*, known from the Patagonian coast and the Falkland Islands, which according to Beyer's observations, mentioned above, also has a colourless blood. It seems very likely that other species, besides the three from South Georgia, the one from Bouvet Island and the one from the Patagonian coast, may have colourless blood, but no information is available.

It is little wonder that the colourless blood of these fish has been overlooked by the scientists who described them, because the red gills of other fishes are soon bleached in museum material preserved in alcohol. It is to be noted that Nybelin's observation of the fact is due to statements made by the scientists who made the catches.

The fact that a good-sized vertebrate can exist without any oxygen-binding blood pigment provokes some interesting questions. Since these fish presumably descend from ancestors with hæmoglobin in their blood, one imagines that only in the cold water of the polar regions could a fish survive which had lost its blood pigment. The *Chaenocephalus* specimens came from water at rather less than 2° C. In the winter farther south the water temperature descends to around − 1·7°, and is always well aerated. In winter the whalers at South Georgia catch the 'white crocodile fish' more commonly inshore, so *Chaenocephalus aceratus* tends probably to avoid the higher temperature found in the fiords in the summer and moves offshore.

Concerning the evolutionary problem raised by these fishes without blood pigment, it is interesting to mention that C. Tate Regan (quoted by Norman[6]) considered that "Antarctica may have long been isolated and that its coasts may have been washed

by a cold sea for a long time, probably throughout the Tertiary Period".

[1] Nybelin, Orvar, Sci. Res. Norw. Antarctic Exped. 1927–1928 *et seq.*, No. 26 Det Norske Videnskaps-Akademi i Oslo, 1–76 (1947).
[2] Nybelin, Orvar, Sci. Res. "Brategg" Expedition 1947–48, No. 2. Publ. No. 18 Fra kommander Chr. Christensens Hvalfangstmuseum Sandefjord, 1–32 (1951).
[3] Roughton, F. J. W., and Scholander, P. F., *J. Biol. Chem.*, **148**, 541 (1943).
[4] Wong, S. Y., *J. Biol. Chem.*, **77**, 409 (1928).
[5] Van Dam, L., and Scholander, P. F., *J. Cell. and Comp. Phys.*, **41**, 3, 1–3 (1953).
[6] Norman, J. R., "Discovery" Rep. 18, 1–104 (1938).

Prof. H. Munro Fox, Bedford College, London, writes the following comment on the foregoing article: Prof. Johan T. Ruud's study of the fishes with colourless blood will be a most interesting surprise to most zoologists, although a few knew of their existence[1]. The fact that there are fishes lacking hæmoglobin is not, however, quite so astonishing as appears at first sight, for the following reason. More than thirty years ago Maurice Nicloux[2] showed experimentally that carp, pike and eels remained alive for four hours, "*pas très incommodés*", in water through which a mixture of air with 2 per cent carbon monoxide was bubbled. Such a gas mixture would quickly kill a man. The hæmoglobin in the fishes' blood was found to be about 90 per cent in the state of carboxyhæmoglobin, that is, incapable of transporting oxygen. The conclusion, although not drawn by Nicloux, is that many fishes when swimming quietly get enough oxygen for their needs in solution in the blood plasma, and they probably only require an additional supply with the aid of hæmoglobin when they are moving actively. Their hæmoglobin is an emergency precaution and the 'ice fish' do without this luxury. Doubtless, however, hæmoglobin is not a luxury but a necessity in the blood of such fishes as mackerel, which cannot get enough oxygen without swimming rapidly through the water[3].

[1] Matthews, L. Harrison, "South Georgia", p. 36 (Wright and Marshall, 1931).
[2] Nicloux, M., *C.R. Soc. Biol. Paris*, **89**, 1328 (1923).
[3] Hall, F. G., *Amer. J. Physiol.*, **93**, 417 (1930).

NEW SURGE GENERATOR AT THE NATIONAL PHYSICAL LABORATORY

By R. S. J. Spilsbury

On April 21 a ceremony was held at the National Physical Laboratory to inaugurate the new surge generator installed by H.M. Ministry of Works for the use of the Electricity Division of the Laboratory. The equipment was put into action by Sir Edward Bullard, director of the Laboratory, and caused to discharge across a chain of forty-five glass suspension insulators, the total length between end fittings being 20 ft. Thanks to the courtesy of the main contractors for the equipment, Messrs. Ferranti, of Hollinwood, the inauguration was followed by a luncheon, at which Sir Edward made a short speech, and Sir Vincent Z. de Ferranti replied.

The need for surge generators arises, of course, from the hazards to which overhead electricity transmission lines, and the transformers, cables, etc., connected to them, are subjected when lightning strikes the conductors or their supporting towers. The effect is to raise the voltage of the line, in a time of the order of a millionth of a second, to a value limited in practice only by the breakdown voltage of some of the insulation, such as air gaps or strings of porcelain insulators: this voltage may be of the order of a million volts for 275-kV. lines. Similar effects occur when switches are operated, though these surges are usually less serious. The voltage step imposed travels along the line without much attenuation, and in due course reaches a transformer or cable. The effect on transformers is particularly serious, since the steep front of the travelling voltage wave causes most of the voltage to appear across the first few turns of the winding, and so to place a stress on the inter-turn insulation many times that which it has to withstand in normal service.

The increasing use of overhead transmission lines and the occurrence of breakdowns due to the causes mentioned above produced, many years ago, a demand for tests designed to simulate the effects of natural lightning, and the surge generator, in conjunction with a high-speed cathode-ray oscillograph, provided the necessary tool. Briefly, such a generator consists of a series of high-voltage condensers which are charged, through fairly high resistances, by a direct-current source of suitable polarity—the effects of positive and negative surges are not, in general, the same—and are then connected in series by the breakdown of air-gaps. The breakdown is initiated by applying a controlled voltage surge to one of the gaps. In this way a voltage impulse, reaching its peak in perhaps a millionth of a second, and decreasing to half this value in about 50 millionths of a second—values which have been internationally agreed as reasonably representative of those which occur in practice—can be applied to a test object.

The National Physical Laboratory has possessed apparatus of this type, built by its own staff, for many years, the open-circuit voltage of the generator being 2 million, and the energy stored in the condensers 20 kilowatt seconds, and, until recently, this has been adequate. Some little while ago, however, it became clear that new equipment was needed; partly because transmission voltages are rising—275 kV. is in use in Great Britain and 380 kV. on the Continent—and partly because the condensers that form the heart of the generator, and are heavily stressed in service, were showing signs of deterioration. It was therefore decided to install new plant, and to design this for the highest voltage that the size of the building allowed—3·2 million volts—so that it would be adequate for the foreseeable future. The dimensions of the main high-voltage laboratory are 120 ft. × 60 ft. × 45 ft. clear height; even so, it was necessary, in order to obtain adequate clearance, to excavate a large pit 8 ft. deep, in which the generator stands.

The apparatus has eight stages, each charged to a voltage of up to 400 kV. by a transformer and metal rectifier: the stored energy is 77 kWs. Each stage consists of two condensers in separate housings, the stage capacitance being 0·12 microfarad. The circular ribbed porcelain housings, with empty porcelains to act as stage insulators, are assembled into a strong four-column structure, which also supports the 50-cm. diameter spheres that form the electrodes of the various air-gaps, and resistors for controlling the shape of the voltage impulse. A condenser is provided to form the high-voltage section of a capacitance voltage-divider, from which

the scaled-down voltage that is applied to the recording oscillograph is obtained.

A glass-fronted chamber, built out into the laboratory at the level of the first floor, houses a desk which incorporates all the controls, and the indicators for safety interlocks, etc. The controls include means for varying the voltage, reversing polarity, setting the inter-stage gaps to a value appropriate for the stage voltage in use, firing the generator at the desired instant, and earthing the apparatus between tests. A device is provided for starting the 'time-sweep' of the oscillograph just before the generator fires, so that the front of the wave is properly recorded. The oscillograph is housed in a steel shield near the control desk.

The new generator is believed to be the largest in Great Britain, and it should be a valuable addition to the research and testing equipment of the Laboratory.

OBITUARIES

Dr. Harold Rutledge

Dr. Harold Rutledge was among the ill-fated passengers who lost their lives when an air-liner *en route* to London from Sydney crashed at Singapore on March 13. The news of his tragic death at the early age of thirty-three has deeply shocked all who knew him, and not least his many geological friends in Britain and Australia. Born on December 15, 1920, at Fairfield, Darlington, he was educated at Stockton Secondary School before entering Bede College in 1939 as a student of the University of Durham. He was elected senior student of the Science Laboratories at Durham, 1941–42, and obtained a first-class honours degree in geology in 1942. He was no less distinguished in university athletics and games—becoming a rugger blue—while his obvious capacity for leadership was recognized by his appointment as sergeant-major of the S.T.C. After graduation, Rutledge entered the Royal Engineers and was soon seconded to the Royal Bombay Sappers and Miners, 1943–46, with whom he saw active service in the Burma campaign, eventually with the rank of captain.

On demobilization, Rutledge spent nearly a year on the staff of the Atomic Energy Division of H.M. Geological Survey; but wishing to return to academic life, he accepted appointment in 1947 as assistant lecturer in geology at Nottingham. A year later I invited him to join the staff of the Grant Institute of Geology, University of Edinburgh, as lecturer in geology, and there he remained until 1952, when he was appointed senior lecturer under Prof. C. E. Marshall at the University of Sydney. He was an outstanding success as teacher and lecturer, clear and vigorous in style and able to inspire in his students the enthusiasm which he brought to all his interests. During his Edinburgh days he joined the Territorial Army as captain in the Military Geology Group (Royal Engineers) and attended manœuvres in Germany and elsewhere.

Rutledge's main research work was concerned with the structure and petrology of part of the plutonic complex of Loch Doon (Galloway) and its metamorphic aureole. His active interest in this area began while he was still an undergraduate; but it was not until he returned to university life that his wish to study it in detail was fulfilled. The first harvest of results brought him a well-earned Ph.D. in 1950. The most significant discovery was the recognition of the fact that, although the complex bears the hall-marks of an intrusion (for example, it transgresses the structures of the country rocks and shows internal vertical lineations), the materials of the marginal part of the granitic mass are transformation products of the adjacent country rocks. Rutledge also made an important tectonic study of the Fannich Forest area in the Scottish Highlands. More recently he was engaged on similar tectonic and petrogenetic problems in New South Wales.

A geologist of initiative and distinction, Harold Rutledge was fearless in spirit and endowed with great vitality and power of endurance. His sudden death, just as he was approaching a period of solid achievement, is indeed a grievous loss. Deep sympathy will be felt for his widow and four-year-old son.

Arthur Holmes

Prof. Marston T. Bogert

By the death of Marston Taylor Bogert at the ripe old age of eighty-six, American and international chemistry has lost one of its most charming and effective personalities. Bogert was educated at Columbia University, where later he became professor and finally professor emeritus of organic chemistry. His main chemical interests lay in the synthesis of heterocyclic compounds such as the quinazolines and thiazoles. He also conducted many investigations on the preparation of derivatives of such aromatic compounds as pyrogallol, thiophene, terephthalic acid, phenacetin and cinnamic aldehyde. He was interested in pharmaceuticals and perfumes, and among the four hundred papers in his name one finds such interesting topics as the relationship between odour and molecular structure.

Bogert was president of the American Chemical Society during 1907–8, and it was during this period that he, together with C. L. Parsons, then secretary of that Society, succeeded in forming the first divisions within the American Chemical Society—a far-sighted political act which in these latter years has undoubtedly greatly assisted in maintaining the cohesion in that vast organization. During the First World War, Bogert was invited to Washington to organize and serve as first chairman of the Chemistry Committee of the National Research Council. He was elected president of the Society of Chemical Industry for the year 1912, and in the years 1918–19 he served as colonel in the U.S. Chemical Warfare Service. After the Second World War, Bogert devoted much of his time and energy to the resuscitation of the International Union of Chemistry, and he was, in fact, the first American citizen to be elected president of that body.

Although somewhat feeble physically and attended by a nurse, Bogert went through the lengthy and trying public functions which attended the seventy-fifth anniversary meeting of the American Chemical Society in New York in 1951. As a public speaker or toastmaster, he displayed a mind capable of much wit and charm, and at scientific dinners the wise always attempted to get a seat near the man with the mauve tie, a sign that Bogert had attended the New York dinner in honour of Sir William Perkin. His loss will be felt by his many friends on both sides of the Atlantic.

Eric K. Rideal

NEWS and VIEWS

Royal Society: New Foreign Members

The following have been elected foreign members of the Royal Society: Karl von Frisch (Munich), distinguished for his work on the physiology of the chemical and visual sense organs of animals, especially insects and fish; Otto Loewi (New York), distinguished as being the first to demonstrate the transmission of the effects of nerve impulses by the release of chemical transmitters; Karl Manne Georg Siegbahn (Stockholm), distinguished for his work on the accurate measurement of X-ray wave-lengths, both by crystal and diffraction-grating methods; Otto Struve (Berkeley, California), distinguished for contributions to observational astrophysics, particularly of double stars.

Electrical Engineering in the University of Wales: Prof. Emrys Williams

Prof. Emrys Williams, of the University College of North Wales, Bangor, has accepted the new chair of electrical engineering at University College, Cardiff, from October 1. Prof. Williams is a native of Liverpool and studied at the Liverpool Institute and the University of Liverpool, where he was awarded the Ph.D. degree for research on electro-acoustics. During 1934–37 he was a member of the scientific staff of the Research Laboratories of the General Electric Company, and was engaged on electro-acoustics, television and carrier telephony. For the following ten years he was lecturer in electrical engineering in King's College, Newcastle upon Tyne (University of Durham), being responsible for the light-current work of the department under Prof. J. C. Prescott. During this time he was associated with Messrs. A. Reyrolle and Co., switchgear manufacturers, Hebburn-on-Tyne, and was chairman of the North-eastern Radio and Measurements Group of the Institution of Electrical Engineers. He is the author of a well-known text-book on valve circuits. Prof. Williams has held the chair of electrical engineering at Bangor since 1947. Although founded largely as a result of a bequest earmarked for hydro-electricity and kindred subjects, the Department of Electrical Engineering at Bangor has in recent years been interesting itself more and more in the light-current branch of the subject. The departure of Prof. Williams coincides with the decision to specialize in this branch, sometimes loosely termed electronics, and a chair of 'applied electricity', within the Department of Physics, is to replace the chair of electrical engineering at Bangor.

Engineering in the University of Wales will thus in future be concentrated at the Cardiff and Swansea Colleges. The new course in applied electricity at Bangor will cover the rapidly growing developments in those parts of light-current electricity which occupy an intermediate position between physics and electrical engineering. Prof. Williams's move to Cardiff will be much regretted by his Bangor colleagues, where his good fellowship and capacity for clear thinking will be greatly missed. His future colleagues at Cardiff welcome him most warmly to his new field of activity, where he may be expected to play a prominent part in the development of education and research into the applied sciences.

Royal Aeronautical Society: Awards

The following awards have been made by the Royal Aeronautical Society: *Honorary Fellowship Diplomas*, to Sir A. H. Roy Fedden and Sir Frank Whittle; *Society's Gold Medal*, which is the highest honour that the Society can confer, to Sir Geoffrey Taylor, for his outstanding contributions to aeronautical science; *Society's Silver Medal*, to Prof. W. J. Duncan, for his outstanding work in aeronautical science and education; *Society's Bronze Medal*, to Mr. H. B. Howard, for his long and valuable work on aircraft structures; *British Gold Medal*, to Mr. A. G. Elliott, for his outstanding practical achievement in the design and development of aircraft engines; *British Silver Medal*, to Mr. R. Brie, for his practical contributions to the development of rotary-wing aircraft; *George Taylor (of Australia) Gold Medal*, to Mr. V. A. M. Hunt, for his paper on air-traffic control to-day and to-morrow; and *Simms Gold Medal*, to Mr. E. D. Keen, for his paper on integral construction—its application to aircraft design and its effect on production methods.

Iron and Steel Institute: Awards

The following awards have been made by the Iron and Steel Institute: *Bessemer Gold Medal for* 1954, to Dr. T. P. Colclough, technical adviser to the British Iron and Steel Federation, in recognition of his distinguished contribution to the development, in theory and practice, of the manufacture of iron and steel; *Sir Robert Hadfield Medal for* 1954, to Dr. A. H. Leckie, technical officer to the Iron and Steel Board and until recently with the British Iron and Steel Research Association, in recognition of his valuable contributions to research in steelmaking; *Andrew Carnegie Silver Medal for* 1953, to G. R. Bish, of Enfield Cables, Ltd., and formerly of University College, Swansea, for his report (written in conjunction with Prof. H. O'Neill, who was not eligible) on the deformation of austenite in relation to the hardness characteristics of steel (*J. Iron and Steel Inst.*, **173**, 398; 1953); *Williams Prizes for* 1953 (two of £100 each), to A. H. Norris, of John Lysaght, Ltd., Scunthorpe, for his paper on soaking pit practice at the Normanby Park steelworks of John Lysaght, Ltd. (*J. Iron and Steel Inst.*, **175**, 353; 1953), and to E. R. S. Watkin, of the Appleby-Frodingham Steel Co., for his paper on railway traffic of the Appleby-Frodingham steelworks (*J. Iron and Steel Inst.*, **173**, 1; 1953); *Ablett Prize for* 1953, to F. Starkey, of Buckley and Taylor, Ltd., Oldham, for his paper on guides and strippers for modern rod and bar mills (to be published later).

Heavy-Water Atomic Reactor for Harwell

Work is beginning on a new atomic reactor at the Atomic Energy Research Establishment, Harwell. This will be the fourth pile to be built at the Establishment and the first in Great Britain using heavy water as a moderator. For the past six years Harwell has had available two piles, BEPO and GLEEP. They have been used for research, and in particular for work in connexion with the design of the piles producing plutonium now in operation at Windscale and the newer nuclear energy electricity generating station now under construction at Calder Hall. However, the more advanced types of power pile now under consideration are likely to operate at a much higher intensity, and this should lead eventually to a reduction of capital costs and lower overall costs of

reactor operation. Accordingly, it has been decided to build at Harwell, in addition to the zero energy fast fission reactor (which has now been operating for some two months), a small research reactor operating at a very high intensity to permit the necessary experimental studies to be carried out. The new pile will also make it possible to produce certain radioactive isotopes such as cobalt-60, which cannot be made with sufficient specific activity in BEPO. The use of heavy water as a moderator enables the required facilities to be obtained at a lower capital cost than would be possible with a graphite-moderated system. The reactor will use as fuel highly enriched uranium which will be supplied from the diffusion plant operated by the Atomic Energy Industrial Group at Capenhurst. General design of the new pile is being undertaken by the Atomic Energy Research Establishment, while detailed design and provision of reactor components will be a responsibility of Messrs. Head Wrightson Processes. The Ministry of Works is undertaking civil and general mechanical work in connexion with site services, building and installation.

The Organization of Pure and Applied Science

THE address on pure and applied science and their appropriate forms of organization, which Prof. M. Polanyi delivered last July in Hamburg at the Congress on Science and Freedom (see *Nature*, **172**, 445; 1953), has now been published as Occasional Pamphlet No. 14 by the Society for Freedom in Science (pp. 13, 1953; 1*s*. 3*d*.; from the Society at the Department of Zoology, University of Oxford). Empirical science, he points out, is based on observations, while technology is a collection of inventions. Not all empirical knowledge forms part of science, and only a part of technology is applied science. While empirical technology is necessarily unsystematic, it can be an important source of information worthy of scientific study. Such technically justified science, like systematic technology, founded on an application of science, forms a field of study lying between pure science and pure technology. The principles for the proper organization of research in pure science are determined by the distinctive characteristics of pure science; and since all real scientific discovery must show originality, expanding the system of science in an unexpected way, scientific discovery is an essentially independent task. Scientific research nevertheless must rely for financial support on public subsidies, and for the effective advancement of science as a whole the individual independent research tasks must be co-ordinated through a spontaneous system operating under the control of scientific opinion. Within this framework the function of the public authorities is to supply the scientist whose work is appreciated by public opinion with the means for pursuing his own interests in science, giving preference to those who have the greater prestige in science. The study of technologically justified branches of science should be cultivated under the auspices, and at the expense, of special interests served by the inquiry, but without drawing away too much talent from the pursuit of scientific inquiries of universal interest. The study of systematic technology should be organized like the advancement of pure science. Finally, Prof. Polanyi urges that, when the State establishes institutions for the cultivation of science, it recognizes a realm of independent ideas and independent men. It admits that the requirements of this realm demand consideration equally with the political and material interests of the society guarded by the State, and by implication the State is committed to foster the advancement of science under the guidance of its own accepted scientific leaders.

Corrosion Prevention and Control

THE appearance in March of the first number of a new journal, *Corrosion Prevention and Control: Engineering—Equipment—Technology* (1, No. 1, March 1954; published from Holland House, 140 Cromwell Road, London, S.W.7; 30*s*. or 5 dollars for one year, and 75*s*. or 12.50 dollars for three years), is in line with the increasing interest being shown in the subject of corrosion prevention. This interest has already found expression in the formation in 1951, by the Society of Chemical Industry, of a Corrosion Group to encourage the presentation and publication of original papers and of reviews. The new journal is, however, the first in Britain to be devoted exclusively to the subject of corrosion, the aim being to present accounts of new developments in a form suitable for rapid appraisal by engineers, chemists and metallurgists who are concerned with the practical application of corrosion knowledge. In the first number this object has certainly been achieved. The editorial comment is of a high standard. Articles refer to cathodic protection, zirconium, metal pre-treatment, protection by paints and resistant plastics. Under the heading "Technical Review" are listed forty-one items relating to progress in corrosion prevention, while abstracts of twenty-three corrosion patents are given in a separate section. With two exceptions, all the articles are anonymous. The sixty-four pages in the first number include ten and a half pages of advertisements. It would be preferable, however, to paginate all advertisement matter separately. The publication of future issues of the new journal will be awaited with interest.

Collected Reprints of the National Institute of Oceanography

THE National Institute of Oceanography in Great Britain, following the example of the oceanographic institutions of the United States, has issued the first volume of the "Collected Reprints" of many of the publications of its staff (pp. vii+61, December 1953; from the Institute, Wormley, Godalming, Surrey). The papers in question were originally published during the years 1949–53 inclusive, and are on many branches of both physical and biological oceanography, including the design and operation of instruments of observation. In accordance with the deliberate policy of the Institute, these papers appeared in a wide range of journals, few of which are of a specialized oceanographic character and some of which cater for the general reader. The alternative would have been for the Institute to publish its own journal, and indeed it does continue to publish the "Discovery Reports", which deal with work based mainly on the observations and collections of the former Discovery Committee, or closely related to that work. But the method of publication chosen for the newer work brings this to the notice of readers outside the field of oceanography, and gives the staff of the Institute the benefit of criticism from those using similar techniques. For oceanography is only the application of the various basic sciences to the acquisition of knowledge of the oceans. Of the papers written for the general reader, a good pro-

portion are by the director of the Institute, Dr. G. E. R. Deacon, and these serve an excellent purpose in popularizing the subject. It is very unlikely that anyone interested in the work of the Institute would have easy access to the majority of the journals used by the staff, and so the issue of collected reprints is specially welcome.

Oundle School Natural History Society

The annual report for 1953 of the Oundle School Natural History Society, edited by B. W. H. Coulson and I. F. Thomas, has recently been published. It is disappointing to read that "Too much is still left to a few keen members and . . . how few members help by providing records". This remark does not necessarily indicate a lack of interest in practical natural history, for all too often the most enthusiastic fail to record their work, which is a pity from several points of view. Three lectures, a series of short talks and a conversazione were some of the indoor activities of the Society during the year, and Oundle School took part in the annual exhibition of the Association of School Natural History Societies at the British Museum (Natural History) on November 7. Among the reports of groups are: mammals, in which a study of bats in Oundle is suggested; birds, recording rarities, phenology and ringing; fish—all coarse, freshwater species; Crustacea; Arachnida; Lepidoptera; Ephemeroptera; Hemiptera; Diptera; Annelida, including physiological experiments on leeches; flowering plants, including phenology, new species and ecology; fungi. Notes are also included in the report on the biology of a lake and a fen together with records of various animals kept in the laboratory. Oundle School is clearly taking advantage of its excellent position for field natural history, and is not lacking in enthusiasm. It is to be hoped, therefore, that the members of its Natural History Society will heed the remarks of the editors of the annual report concerning lack of written records, for this is very important.

Flora of the Belgian Congo

The fourth volume of the "Flore du Congo Belge et du Ruanda-Urundi" (Publ. Inst. Nat. pour l'Étude Agron. du Congo Belge, pp. 314, with map and line drawings; Brussels, 1953) deals with the Spermatophytes, Papilionaceae (Part I), of this rich and varied floristic region. Accounts of the tribes Sophoreae, Genisteae, Trifolieae and Loteae, each contributed by a different author, are here given; the other tribes of this order will be dealt with in two subsequent volumes. Analytical keys are provided for the tribes, genera and species; the genera and species being described in detail (in French) with notes on their distribution and habitat and occasional illustrations. The publishers are to be congratulated on the clarity of the arrangement and text.

Arid Zone Research

The general conference of Unesco at its sixth session held in Paris in 1951 authorized the Director-General "to collect and disseminate information on research being carried out on problems of the Arid Zone and on the organizations, scientists and engineers engaged in such research". As a result, the secretariat undertook a survey among the member States of the institutions primarily devoted to scientific and technical research on problems of arid and semi-arid areas. A directory has now been published which gives detailed information about these institutions. The ninety institutions listed are located in sixteen countries and seven dependent territories spread over the five continents of the world. Copies of the directory can be obtained from H.M.S.O., price 8*s*. 6*d*.

British Institution of Radio Engineers: Convention in Oxford

The third post-war convention of the British Institution of Radio Engineers will be on industrial electronics and will be held in the University of Oxford during July 8–12. The Institution's Clerk Maxwell Memorial Lecture will be delivered in the Clarendon Laboratory, Oxford, by Sir John Cockcroft, director of research, Atomic Energy Research Establishment, Harwell, on the evening of July 8. More than thirty papers will be presented at the six sessions, which will be as follows: industrial applications of electronic computors; industrial applications of X-rays and sonics; nucleonic instrumentation and application; electronic sensing devices (transducers); process control; and industrial aids to production. The registration fee for members of the Institution is 10*s*. 6*d*. a day or £1 11*s*. 6*d*. for the whole convention (for non-members, £1 1*s*. and £3 3*s*., respectively). Accommodation may be reserved at Christ Church, Oxford. A detailed programme and reservation forms can be obtained from the Secretary of the Institution, 9 Bedford Square, London, W.C.1.

South-Eastern Union of Scientific Societies: Congress in Maidstone

The fifty-ninth annual congress of the South-Eastern Union of Scientific Societies will be held in the Museum and Art Gallery, St. Faith Street, Maidstone, during June 10–13. After his induction on June 11, the new president of the Union, Dr. Glyn Daniel, will give an address on "The Art of Megalith Builders". The Union is divided into archæology, botany, geology and zoology sections, and the individual presidents of the sections and the titles of their addresses will be as follows: *Archæology*, F. C. Elliston Erwood, on the present state of monastic archæology in Kent; *Botany*, J. E. Lousley, on the amateur botanist in 1954; *Geology*, H. E. P. Spencer, on the Pleistocene period and work for the amateur geologist; *Zoology*, Dr. G. E. Newell, on animal zones of the North Kent coast. Further information can be obtained from the honorary local secretary for the meeting, L. R. A. Grove, Museum and Art Gallery, St. Faith Street, Maidstone.

Physical Society: Summer Meeting

The annual summer meeting of the Physical Society will take the form this year of three open lectures (no ticket of admission being necessary), given in connexion with the General Assembly of the International Union of Pure and Applied Physics, and will be held at the Royal Institution, 21 Albemarle Street, London, W.1, on July 7 and 9 at 4.30 p.m. and on July 13 at 2.30 p.m. The lectures will be as follows: fields and particles, by Prof. J. A. Wheeler (Palmer Physical Laboratory, Princeton University); the European Organization for Nuclear Research, by Prof. E. Amaldi (Guglielmo Marconi Institute of Physics, Rome); and microwave experiments in the physics of solids, by Prof. C. Kittel (University of California, Berkeley).

Easterfield Medal of the New Zealand Section, Royal Institute of Chemistry

THE New Zealand Section of the Royal Institute of Chemistry has instituted a new silver medal, to be known as the Easterfield Medal, in honour of the late Sir Thomas Easterfield, the first professor of chemistry in Victoria University College, Wellington, and later the first director of the Cawthron Institute. The Medal will be awarded every two years to a New Zealand chemist less than thirty-five years of age who has carried out research work of outstanding quality and originality, the major portion of it being done in New Zealand. The first award will be made this year, and further details can be obtained from the honorary secretary, New Zealand Section, Royal Institute of Chemistry, P.O. Box 250, Wellington, C.1.

Royal Institution: Officers

AT the annual meeting of the members of the Royal Institution, held on May 1, the following officers were elected: *President*, Lord Brabazon of Tara; *Treasurer*, Dr. L. H. Lampitt; *Secretary*, Mr. S. Robson; *Managers*, Mr. E. R. Davies, Sir Walter Drummond, Sir Alfred Egerton, Mr. H. S. Gibson, Mr. A. C. Hartley, Mrs. H. K. Hawkes, Prof. A. V. Hill, Mr. L. B. W. Jolley, Dr. H. Lowery, Mr. A. J. Philpot, Mr. W. E. Schall, Mr. P. H. Schwarzschild, Sir George Thomson and Mr. Frank Wakeham; *Visitors*, Mr. W. W. Abson, Mr. F. G. Brown, Dr. H. K. Cameron, Mr. A. D. R. Caroe, Mr. A. H. Ewen, Prof. James Greig, Wing Commander G. e. Hughes, Dr. G. M. Lees, Prof. Kathleen Lonsdale, Mr. Arthur Marshall, Mr. M. M. Melinsky, the Hon. Philip Samuel, Dr. P. C. Spensley, Mr. W. R. Stevens and Dr. Norman Stuart.

Royal Photographic Society Exhibition of Underwater Photography

AN exhibition of photographs taken under water has been arranged by the Royal Photographic Society and will be on show in its house at 16 Princes Gate, London, S.W.7, until May 29 (Sundays excepted), admission free. It comprises about a hundred photographs, in monochrome and colour, of subjects by Commandant Jacques-Yves Cousteau, Henri Broussard, Dimitri Ribikoff, and Robot-Berning and Co., and members of the Under-water Explorers Club. Other items include photographs from Marconi's Wireless Telegraph Co., Ltd., and Siebe Gorman and Co., Ltd., taken off the monitor screen during underwater television operations. The Royal Naval Scientific Service has contributed a special section of fifty prints, showing propeller studies, wreck surveys and experimental techniques.

Earthquakes during February

THERE were some twenty-six strong earthquakes during February, twelve of which had instrumental magnitude 6 and greater. The greatest two had instrumental magnitude 7¼ and occurred on February 1 near the Volcano Islands (lat. 24½° N., long. 142½° E.) and on February 11 in Ningsia Province, China (lat. 39½° N., long. 101° E.), respectively. The shock which did most damage during the month had instrumental magnitude 6¼ and an epicentre near lat. 17½° N., 92½° W., causing extensive property damage at Chiapas in Mexico. Two earthquakes occurred at a focal depth of 600 km., the first being on February 14 near the Fiji Islands, and the second on February 20 in the Flores Sea. Reports were received from the United States Coast and Geodetic Survey in co-operation with Science Service and the Jesuit Seismological Association, Durham, Lwiro (Belgian Congo), Pasadena, Strasbourg, Toledo and Uccle.

Announcements

WE regret to announce the death on April 25 of Lady Mary Lilian Boyd Dawkins, widow of Sir William Boyd Dawkins, aged ninety.

THE Council of the Royal Society of Edinburgh has awarded the Keith Prize for the period 1951–53 to Dr. D. E. Rutherford, Department of Mathematics, University of St. Andrews, for his paper, "Some Continuant Determinants arising in Physics and Chemistry", and other publications in the *Proceedings* of the Society.

THE first Dickinson Memorial Lecture of the Newcomen Society will be delivered by Prof. Charles Singer in the Science Museum, London, S.W.7, on May 12 at 6 p.m. The Lecture is to be a biennial one.

AT the annual meeting of the Zoological Society of London on April 29, Sir Landsborough Thomson was elected president in succession to Lord Alanbrooke. Dr. T. C. S. Morrison-Scott was elected treasurer, and Lord Chaplin secretary. New members of Council are Captain K. Caldwell, Mr. A. Ezra, Lord Forester, Dr. H. W. Parker, Mr. Peter Scott and Mr. S. Wilson Kitchen.

MR. J. E. CUMMINS, chief scientific liaison officer, Australian Scientific Liaison Office, London, is returning to Australia after six years in London. He will be succeeded by Mr. Walter Ives, who is at present secretary (agricultural and biological sciences) of the Commonwealth Scientific and Industrial Research Organization, Melbourne.

THE Minister of Transport, the Right Hon. Alan Lennox Boyd, will open the new research laboratory and proving ground of the Motor Industry Research Association at Lindley, near Nuneaton, Warwickshire, on May 21.

AN exhibition on "Dry Rot and Woodworm" will be opened at the Royal Sanitary Institute (90 Buckingham Palace Road, London, S.W.1) on May 12 by the Right Hon. Sir David Eccles, Minister of Works. The Exhibition is being presented in collaboration with the Department of Scientific and Industrial Research and the Central Office of Information, and will remain open until July 17.

THE British Society of Rheology is holding a conference on "Rheology in Mechanical Engineering" in the Mechanical Engineering Research Laboratories, East Kilbride, near Glasgow, during June 10–12. The conference will be free and open to anyone interested in this field. Application forms, to be returned before May 15, can be obtained from Dr. D. P. Feltham, Flat H.12, Sloane Avenue Mansions, London, S.W.3.

THE Committee on Vacuum Techniques is holding a symposium during June 16–18 at the Berkeley-Carteret Hotel, Asbury Park, New Jersey. About twenty-five papers will be read, discussing nomenclature and standards; new equipment and instruments; fundamental developments in vacuum technology; methods and techniques; applications; and processes. Persons and organizations interested in attending the symposium should write to the Committee on Vacuum Techniques, Box 1282, Boston 9, Mass.

MYXOMATOSIS IN RABBITS IN GREAT BRITAIN

THE Advisory Committee on Myxomatosis in Rabbits, appointed in 1953 by the Minister of Agriculture and Fisheries and the Secretary of State for Scotland, has now issued a report* which describes the history and nature of this disease, its present distribution in Great Britain, the protection of domesticated rabbits from it, the harm done by rabbits to agriculture and the present recommendations of the Committee with regard to the disease. Myxomatosis was first reported in 1898 from Montevideo. It is a disease caused by a virus which, so far as we know at present, affects rabbits only. Man, domesticated and other animals cannot be infected with it. It is transmitted purely mechanically to rabbits by the fleas, lice, mosquitoes and mites that suck the blood of the rabbit, and these blood-sucking arthropods act just as a pin infected with the virus might. An infected pin may remain capable of transmitting the virus for twelve days, and the mouthparts of a blood-sucking arthropod may remain infective for twenty-five days. The disease has been used successfully in France and Australia for killing large numbers of rabbits, and the benefit to agriculture is already evident. Recently, the disease has spread to Luxembourg, Belgium, Germany, the Netherlands and Spain. During 1936–38 attempts were made to establish the disease among the rabbits on Skokholm Island, off the Pembrokeshire coast, but these failed. In 1953 the disease broke out in Kent and East Sussex, its source being unknown. Attempts were then made to control its spread; but since then, further outbreaks have been confirmed, and at present six of these have been recorded from Kent, two from East Sussex, three from Essex and one from East Suffolk. The localities where these outbreaks have occurred are shown in a map published with the report.

During laboratory experiments on the disease and in natural outbreaks of it, more than 99 per cent of rabbits infected have died; but those that survive develop an immunity, and it is believed in Australia that rabbits there are becoming immune to the disease and that the very high mortality of rabbits that has occurred in that country is now falling considerably. The development of immunity may therefore prevent the use of the disease for killing rabbits in the future.

The report contains a valuable section on the economics of the wild rabbit. Representatives of the rabbit meat, fur, fur felt and fur felt hat trades have estimated that their trades deal each year with 40 million rabbits. The rabbit meat obtained is worth about £7 million and the skins about £8 million, £3½ million of the latter being represented by exports to the United States. Thus wild rabbits provide in Great Britain a total income of about £15 million a year.

Estimating the cost of the harm that wild rabbits do, the Committee states that nine rabbits eat about as much as two sheep, so that the estimated population of Great Britain of about 60–100 million rabbits, which feed largely on agricultural crops and grass, can deprive domesticated animals of a great deal of food. It has been estimated that rabbits may cause losses of the order of 160,000 tons of wheat a year, which is worth £5·2 million, and damage to other cereals of the same order, so that the annual loss in this respect is of the order of £15 million. The most extensive damage is done to grassland, the cost of this being estimated at £21 million a year. Rabbits also damage kale, swedes and other vegetables and also fruit trees; the harm they do to young trees in forestry plantations makes it necessary to protect these trees at an annual cost of about £2 million. The Committee considers, in fact, that the damage done by wild rabbits in Britain costs three or four times the income they bring to the trades dealing in them. In Australia it was estimated that the destruction of rabbits resulted in an increase of rural production worth £50 million during 1952–53 alone.

In order to reach its conclusions the Committee consulted representatives of the animal welfare societies, agriculture, forestry, the trades dealing in rabbits and those concerned with the domestic rabbit. The chairman of the Royal Society for the Prevention of Cruelty to Animals and the chairman of the Committee on Cruelty to Wild Animals are members of the Committee. The animal welfare societies supported the organization of a national campaign to exterminate the wild rabbit by every humane method available as a means of preventing future suffering. The representatives of agriculture and forestry, with the exception of the National Farmers' Union of Scotland, were not generally in favour of deliberate spread of myxomatosis; they felt that, until we know more about the disease, it should be allowed to spread naturally. The representatives of trades dealing in rabbits were concerned about the possible effects of the disease on their trades, and the producers of domestic rabbits sought protection for the domestic rabbit.

The Committee concluded that attempts to control the natural spread of the disease would serve no practical purpose, but that, for humanitarian, legal and other reasons, no attempt should be made to help the spread of the disease or to introduce it where it does not naturally occur. It recommends that the disease should be allowed to run its natural course and that, whenever outbreaks occur, attempts should be made to eliminate survivors of it before they are able to produce numerous offspring immune to the disease. The importation of such live rabbits as the cotton-tail rabbit, which might rapidly become a pest in Great Britain, should be prevented. Special protection should be given to domestic rabbits and information about the best methods of doing this should be distributed. The vaccine which is the only known preventative of the disease should be made available at a reasonable cost to rabbit breeders. The Committee is, meanwhile, watching the disease, and it has started research on it. Further advice will be issued as occasion arises. G. LAPAGE

* Ministry of Agriculture and Fisheries; Department of Agriculture for Scotland. Report of the Advisory Committee on Myxomatosis. Pp. iv+14. (London: H.M.S.O., 1954.) 9*d*. net.

NATIONAL COLLEGE OF HOROLOGY AND INSTRUMENT TECHNOLOGY

THE National College of Horology and Instrument Technology was founded in 1947 for the training of technicians in the horological and instrument industries. It is accommodated within the Northampton Polytechnic, London, E.C.1. Shortly after the Second World War the horological manufacturing industry was re-established, and in consequence there was a great need for engineers with a good knowledge of horological theory and of production methods applicable to fine mechanisms. The first course instituted at the College was a three-year diploma course in horology for students over the age of sixteen. The standard of this diploma is of the order of the first part of a degree in engineering, and the curriculum, in addition to covering academic subjects, includes a liberal allocation of time to workshop technology and practice.

During recent years the academic content of the curriculum of the diploma course has been modified somewhat to include instrument technology as well as purely horological work, the remainder of the theoretical and almost the whole of the practical work of the course being found to be admirably suited to the needs of the instrument, as well as the horological, industry. In fact, many students leaving the College obtained posts in the field of instrument design, development and manufacture, even before these modifications were adopted.

The College is equipped with a comprehensive range of general and specialized machine-tools and instruments suitable for almost any branch of fine-instrument and light-engineering production, and the variety of practical work given to students in this course is made as wide as possible. In addition to the specialized facilities in the National College itself, the full resources of the departments of the Polytechnic, including instrument engineering, mechanical and electrical engineering, applied physics, metallurgy and mathematics, are available for students at the College, these departments providing specialist lecturers in individual subjects.

Building extensions costing upwards of £350,000 are at present in hand at the Northampton Polytechnic, and the Instrument Engineering Department has acquired completely new workshops and laboratories. These extend its scope considerably and improve the facilities it is able to offer to the National College in connexion with advanced courses in instrument technology. Extensions to the premises of the National College are also planned which will more than double the space at present available. This space will be devoted to advanced workshops and laboratories for students in both horology and instrument technology.

To co-ordinate the diploma course in horology with training in industry, the British Clock and Watch Manufacturers' Association has sponsored a student-apprentice scheme which supplements the three years spent at the College with a further two years in the works of a member firm. Deferment from military service is normally granted for the full five years and, during the final two years, student-apprentices are expected to continue part-time for a Higher National Certificate. This enables them to qualify for graduateship of one of the engineering institutions—mechanical, electrical or production—partial exemption being granted on gaining the College diploma.

Extension of Courses

Although many ex-students are employed on instrument engineering with member firms of the British Clock and Watch Manufacturers' Association, the governors of the College are anxious to extend its facilities to other branches of the instrument industry. To this end, discussions have recently been held with the Scientific Instrument Manufacturers' Association to ascertain the types of courses best suited to the industry. An open day was held at the College on March 16 to enable member firms of the Association and other interested persons to inspect the workshops and laboratories, and this attracted some sixty to seventy representatives, many of whom expressed surprise and pleasure at the high quality and variety of equipment.

The two main courses proposed have received wide support. The first proposal is to establish a diploma course in instrument technology having much in common with the present diploma course in horology; with the development of this course, it may well be that horology will take its place as a special branch of instrument technology.

The second proposal is for an advanced course, one year in duration, for postgraduate and post-Higher National Certificate students. At present the instrument industry recruits to its technical and executive grades graduates in physics and engineering. It is found necessary to give these men a period of training in the industry before they are fully competent, and it is suggested that the College could undertake a good deal of this training. The actual length of this course would be one session, eight months in duration.

The curriculum will include a certain number of basic subjects such as applied physics, instrument design, workshop technology, metrology and industrial administration, as well as a number of optional subjects such as advanced mathematics, instrument workshop practice and metallurgy, together with particular branches of instrument theory such as mechanical, electrical, electronic, optical, industrial control and servo-mechanisms. It is envisaged that students holding degrees or Higher National Certificates in physics may well require tuition and practical experience in engineering, production and management subjects, as well as a more detailed knowledge of the technology with which their firm is associated. Students who have taken general engineering will need further tuition in applied physics, production and instrument engineering, while those who have National Certificates in production engineering may wish to study applied physics and perhaps some basic engineering subjects.

National colleges are intended to serve and co-operate fully with their respective industries, and it is therefore essential that approved forms of student-apprenticeships and postgraduate scholarships should be established by the trade associations or the larger firms.

Production and Research

Finally, it should be noted that the interests and facilities of the College are by no means limited to formal instruction. A certain amount of specialized

manufacture is already undertaken where the work involved provides valuable experience for students, and the College is well equipped to accept suitably qualified students for research in various branches of design, development and production applicable to instruments, fine mechanisms, horology, automatic control and so on.

UNIVERSITY COLLEGE OF THE WEST INDIES

DEPARTMENT OF ZOOLOGY

By Prof. N. MILLOTT

THE West Indies have always formed a fruitful area for the prosecution of zoological research, and now, as in the past, excellent work is being done by the Institute of Jamaica and a well-established Natural History Society. In recent years the facilities for such studies have been increased by the establishment of a Department of Zoology in the new University College of the West Indies. Though facilities have been in existence from the inception of the College in 1948, it is only recently that they have been fully realized by the housing of the Department in permanent accommodation.

The Department is situated in the University grounds of some seven hundred acres and is readily accessible, being seven miles from Kingston. It is designed and organized for both teaching and research. As a teaching unit it is responsible for the training of undergraduates for degrees in science, and the intermediate and First M.B. examinations of the University of London, with which the College is privileged to maintain a special relationship. Provision has also been made for the training of post-graduate students for higher degrees.

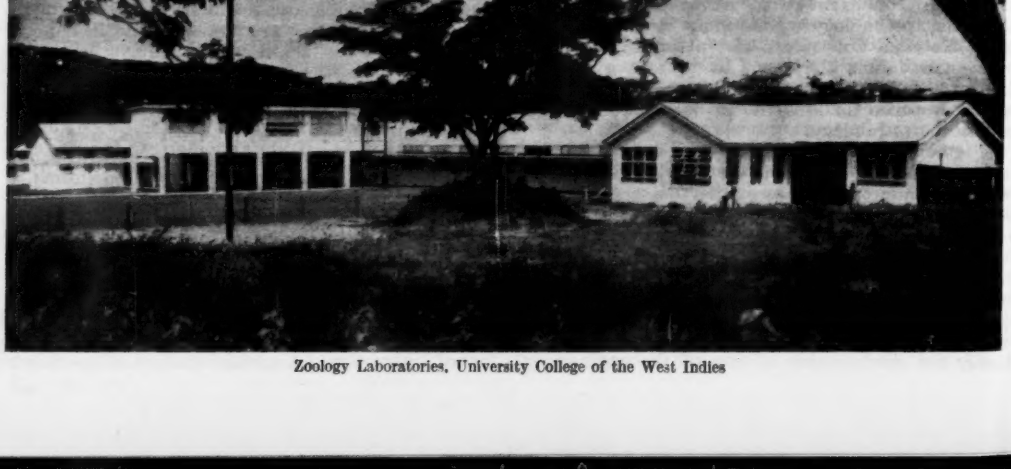
The buildings were designed by the University College architects, Messrs. Norman and Dawbarn, of London, in conjunction with the head of the Department, and they were completed in October 1952.

Mostly on one level, the laboratories include a large elementary and a smaller advanced teaching laboratory, suitable for the study of systematic zoology, animal morphology, histology, etc. In addition, there are ar experimental laboratory for physiological studies, a small museum, an aquarium room, offices, a photographic dark room and a lecture room. Two research laboratories are provided. All the laboratories are fitted with the usual services, and in addition, both the experimental laboratory and the aquarium room have compressed-air mains. Very shortly a salt-water circulator will be installed in the aquarium room. The furnishings are executed in local woods and were designed and constructed on the University College site.

The laboratories have been equipped and staffed, so far as possible, for a comprehensive study of zoology, rather than for highly specialized studies of particular aspects. In this way it is hoped that the Department will not only be able to give its students an adequate training in the ever-widening sphere of zoology, but will also provide a type of research centre that has long been required in the central Caribbean.

From the first the Department has aimed at encouraging visiting research workers to use its laboratories and in this a real beginning has been made, the Department having already accommodated research workers under the Fulbright scheme and two members of the staff of the University of Glasgow. It is hoped that other institutions and organizations will encourage investigators to use the facilities now available.

Since the beginning, members of the teaching staff of the Department have been actively engaged in research, and the existing programme falls into six main divisions. A study of the Collembola of Jamaican soils is being undertaken, which, initially, will involve the determination of species, and later, studies of population density and distribution. The Nuffield Foundation has generously offered financial assistance for this study. A second division consists of evolutionary studies on snakes and lizards. These have involved investigations of the details of speciation in Jamaican reptiles, comparative anatomical studies including a special study of the retina, and distributional studies which bear on the evolution of higher taxonomic categories and the problem of the origin of snakes. Researches on the thymus of



Zoology Laboratories, University College of the West Indies

reptiles and mammals, particularly primitive forms such as the sloth, are being pursued, and studies are also being made of the anatomy of the rare, beaked whale *Mesoplodon*, two individuals of which were recently washed up on nearby shores. Hitherto undiscovered platyctenid ctenophores have raised interesting problems in connexion with their phylogeny and distribution, which are now being tackled in the Department. Lastly, a study of local echinoids has revealed in certain forms a striking sensitivity to light. Since they lack morphologically defined photoreceptors, their mechanism of perception is clearly of great interest and it is being analysed in detail in one species. Rather unexpectedly, the study has yielded interesting results in relation to melanogenesis in this form, and the research has recently received the support of the Rockefeller Foundation.

Visiting workers have undertaken research on the taxonomy and distribution of Jamaican frogs, the effect of thyroid inhibitors on the development, and that of phenylthiourea on the pigmentation, of *Eleutherodactylus*. The bionomics of black widow spiders and scorpions, and the feeding processes of bivalve molluscs, have also been investigated.

The geographical location of the Department is admirable for zoological studies, since the surrounding collecting grounds are readily accessible by good roads. Seaward, some ten miles distant, lies Kingston Harbour with fertile collecting grounds afforded by cays, lagoons, mangrove swamps and innumerable bays and inlets. The north coast of the island with its accessible coral reefs is some thirty miles away, and nearby salt ponds, periodically land-locked, offer a worthy opportunity for ecological studies. Landward, there are areas showing diverse climatic, topographical and geological conditions. From dry plains, mountains clothed in forest rise in succession to 7,000 ft., and most areas are accessible by road.

In general, these areas yield an abundance of animal forms for systematic, ecological and physiological studies. Echinoderms, molluscs and many insects occur in spectacular quantity. The embryologist will find much of interest in the abundant eggs of lizards, geckos and anurans with direct development. For those interested in migration problems, it is appropriate to note that the island is visited not only by migrant birds but also by migrant butterflies.

In the past it was necessary for many visiting research workers to limit their activities largely to collecting and preserving. Such drastic limitations are fortunately no longer necessary, and with the facilities of modern, well-equipped laboratories at their disposal, they may now undertake experimental work no less readily than microanatomical or cytological studies, for the Department is equipped with a comprehensive range of research microscopes, rocking, rotary, sliding and freezing microtomes, kymographs, thermostatic baths, Warburg apparatus, centrifuges, *p*H meters and a Beckman spectrophotometer.

Finally, it might be mentioned that library facilities are available, not only in the University College, which maintains a first-class library with a microfilm service, but also in the nearby library of the Institute of Jamaica, the staff of which render invaluable assistance to visiting research workers. It is hoped that with these added facilities many zoologists who hitherto have demurred will seize the opportunity of extending the horizon of their animal studies and make use of the facilities that are now available in this supremely fascinating part of the earth.

ATOMIC ENERGY AND MORAL ISSUES*

OWING to the controversial nature of the subject of the moral issues involved in the utilization of atomic energy, two speakers, Prof. Kathleen Lonsdale and Sir George Thomson, were asked to express their views. Their respective methods of approach to the subject, which to a large extent centred around the morality of war, may be summarized in Prof. Lonsdale's words: "I believe that all war is wrong, with whatever weapons, because it is made up of hatred, falsehood and savagery; and because it perpetuates these things. . . . But even if these fundamental objections to war *as such* are set on one side, I still see in an atomic war, or indeed in any other form of future world war based on scientific super-weapons, a menace to every kind of decency towards one another as human beings that we have painfully achieved throughout the ages. Men die horribly every day; buildings decay and become ruins. What is more horrible is that we ourselves, whether as a means of offence or of retaliation for aggression, should deliberately let loose hell on earth; and that is what atomic warfare would be, no matter how much we may deceive ourselves into supposing that we can ameliorate it with the deep shelters, protective clothing and Geiger counters of civil defence". And in Sir George Thomson's words: "Two societies, or the same society at different times, may with perfect honesty have different codes and judge differently what is right in different circumstances. This is, partly at any rate, the answer to the question of expediency. Right and wrong exist quite independently of expediency. But a code which does not consider expediency is a bad one and will not last. The consequences of acts *do* matter for moral judgments. It is permissible to indulge in the alkaloid contained in tea, but not in that contained in heroin simply because the long-term consequences are different".

Prof. Lonsdale rejected the doctrine of expediency and appealed to Christianity as a standard by which the rightness or wrongness of any course of action may be judged. "I know," she continued, ". . . it is not possible to *prove* that there are any *absolute* standards. Certainly none of us can claim that ours are the only true standards. We know, indeed, that our standards as scientists have at least different priorities from those of some other people. . . . Yet whatever our priorities we do know that there is for us and for all men a 'moral law within', however much we may ignore it or attempt to rationalize it away. Truth, generosity, brotherly love, justice, mercy, integrity are recognized as good, and the Golden Rule 'As ye would that men should do to you, do ye even so to them' still has a compelling force for us which is its own authority. . . . Very often the choice that confronts us in issues relating to Atomic Energy is one between a *certain* wrong to other people and a *possible* injury to us or to our nation. When this is so then I submit that it is morally wrong to put a possible or probable wrong to ourselves, or even to those we love, before an absolutely certain injury to others.

* Summary of lectures by Prof. Kathleen Lonsdale, F.R.S., and Sir George Thomson, F.R.S., being the sixth of a series of public lectures arranged by the Atomic Scientists' Association and the Department of Extra-Mural Studies, University of London (see also *Nature*, February 27, p. 386; March 13, p. 477; March 27, p. 573; April 3, p. 621; and April 10, p. 668).

"I believe that this is relevant in our discussion of whether we should build up stockpiles of atomic weapons, even as a means of preserving peace. I want peace to be preserved, not simply because human beings would die horribly in war in which atomic weapons were used, but because in wartime ideals are the first casualties, and because I believe that our democratic ideals would not survive an atomic war. In many ways atomic weapons are intrinsically no different from other weapons—I cannot see that it is more terrible to die in the heat of an atomic blast than to die from the effects of 'napalm', or even from the accidental flare-up of a nylon garment."

Against this point of view, Sir George stated: "I assume, in common with the great majority of Christians of all ages, that though war is an evil there are occasions on which it is the duty of governments to declare it and of their citizens to help to wage it. After all, if one does not assume this there is no specific problem, one would hardly suppose that atomic bombs are right if swords are wicked. The main question is 'what limitations if any should a country place on the methods it is prepared to use in a war it believes just', with as a secondary one 'are these limitations absolute or do they depend at all on what the enemy does?'

"It seems to me that since the object of fighting is, or should be, to bring about a just peace, a method of war is good in proportion as it is effective and bad in proportion as it causes suffering and economic loss. Its merit is a sort of ratio of the two. Notice, method of war, not weapon. The rifle is perhaps as humane a weapon as man has invented, but if it is used to massacre a defeated population that method of war is a very bad one."

In discussing whether a stockpile of atomic bombs will minimize the possibility of another war, he said: ". . . the presence of a lot of atomic bombs in the world very substantially reduces the chances of a big war. The United States is very bomb-conscious, and the mere fact that Russia did not force matters in Europe when she was so strong is evidence of her fear. . . . There is, I believe, a genuine fear of all-out war and a feeling that in a major war there will be no gallery seats. Even the horrors of the hydrogen-bomb, for which there is no moral defence as a weapon . . ., are helping to the cause of peace. I believe attempts at disarmament are futile and that the bitterness and back-biting which abortive disarmament conferences inevitably cause are a real danger to peace".

ACTA HYDROPHYSICA

A NEW JOURNAL OF MARINE PHYSICS

THE first three issues of the new journal, *Acta Hydrophysica**, sponsored by the Institute for Physical Hydrography of the German Academy of Sciences, Berlin, have recently been published and distributed to various addresses on exchange terms though without any indication as to the price at which this well-produced journal can be bought. The three numbers have 139 pages in all (21 cm. × 15 cm. in size), and it is announced by the publishers (Akademie-Verlag, Berlin) that its appearance will be irregular. The journal is edited jointly by Dr. H. Ertel, director of the Institute of Physical Hydrography at the Humboldt University in Berlin, and by Dr. J. Fischer.

If, as may safely be surmised, the purpose of the Institute of Hydrography is to launch a journal devoted exclusively to what would be known in Britain and the United States as 'physical oceanography', then its new publication stands as the first to be confined to that limited but very important field. Because of the inevitable and ever-growing attention to problems within the field of marine physics, a real need has been felt in Britain for a specialist journal in which papers dealing with ocean physics and related meteorology could be published, and good wishes will accordingly be extended to the new German venture.

In an opening paper by H. P. Schmitz on the processes associated with the cooling of inland lakes, it is asserted that relationships hitherto used in connexion with turbulent heat conduction in water are assailable on the grounds that they took no account of the dependence of the water density upon temperature. Though, under frequently occurring conditions, the same equation for turbulent heat conduction is obtained as that arrived at by Wilh. Schmidt, more complicated conditions usually arise —particularly around the temperature of maximum density and through warming. The treatment by Schmitz is unidimensional only, and the conditions where such treatment is permissible are recounted. He deals with the cooling of a column of lake water from surface downwards in the presence of thermal convection and turbulent heat conduction, and derives a connexion between the depth reached by convection and the time of its attainment when surface temperature fluctuations, cooling-rates and the magnitude of the turbulent heat conduction are known. He studies two cases: when there is a night-produced discontinuity layer, and when there is a night-time decrease of vertical temperature gradient —both due to the joint effects of thermal convection and turbulent heat conduction. Finally, he deals with the cooling of a column of lake water the temperature of which lies between those of freezing and of maximum density, and derives a differential equation which serves for the solution whatever be the commencing and the marginal conditions.

An article by J. Fischer on a nomographical process in oceanography presents a new method of using projection paper to carry out certain computations by means of accepted processes of nomography, and applies it to two examples concerned with rainfall. Adrian Steleanu writes on the problems posed in lake plankton studies by the degree to which physical factors exert influence and impose distribution limits. He concerns himself with light penetration and temperature gradients in the vertical, the influence of light having only biological significance, whereas temperature has both that and mechanical influence.

Sinking-speed is dealt with in the light of Ostwald's relationship of that quantity to body density, viscosity and body form, and, finally, a discussion is given around the various lake plankton forms characteristic of the four seasons. A 27-page paper by K. Vollbrecht deals with the axial arrangement of quartz grains in sandy sediments. By studying a definite selection of suitable grain sizes, the axial arrangement of quartz grains can (says Vollbrecht) show reliably what the conditions of currents must have been when the sediment was laid down, par-

* Deutsche Akademie der Wissenschaften zu Berlin: Institut für Physikalische Hydrographie. *Acta Hydrophysica*, Band 1, Heft 1, 1953. Pp. 56. (Berlin: Akademie-Verlag, 1953.)

ticularly as to direction. H. Griesseier and K. Vollbrecht report upon experiments carried out to throw light on the building of bars off river mouths. They discuss the effects due to the slackening of water speed as the cross-section increases, and those due to electrolytic dissociation in sea-water. They also discuss the dependency of bar-building upon the contact of river and sea waters. H. Griesseier writes on the reflexion of sunlight impinging directly upon an agitated water surface, and in the final article, by Joh. Fischer, there is a discussion of a nomographic method for evaluating trigonometrical functions.

J. N. CARRUTHERS

CARNEGIE UNITED KINGDOM TRUST

REPORT FOR 1953

THE fortieth annual report of the Carnegie United Kingdom Trust covers the year 1953*, the mid-year of a quinquennium, and records the opening of new premises for the Scottish Central Library at Fisher's Close, in the Lawnmarket of Edinburgh, on November 5 as the most important event of the year in the field of general educational services. The new building provides space both for the storage of books and for the proper accommodation of the library staff and has been planned with an eye to future expansion.

Out of reports on the employment and training of social workers, issued in 1947 and 1951, proposals have now emerged for the establishment of a one-year course of 'basic' training, designed to follow the acquisition of a general university qualification in social science and providing an alternative to more specialized courses of training now required by many bodies employing social workers. A provisional allocation of £20,000 has been made towards the cost of a four-year experiment. A grant of up to £30,000 has been offered to the governing body of Brentwood, the recuperative centre for mothers, with children, whose family life has gone wrong, maintained by the Community Council of Lancashire to enable extensions and improvements in the accommodation to be made. In October 1953, Dr. John Spencer took up his duties as a director of a social project in Bristol concerned with the establishment of practical means of tackling those stresses and strains which arise in a developing community in the form of delinquency and other disturbances. The project, which is designed to cover a period of five years, will place its main emphasis on encouraging local initiative and on getting local residents to accept more responsibility for their community life, and £25,000 has been allocated by the Trust for this project.

It has been necessary to abandon the residential clinic for difficult children, opened in November 1950; but the Trust has asked the Family Welfare Association to arrange for the preparation and publication, under the title "Family Casework and the Country Dweller", of an account of two experiments in rural casework in Oxfordshire and parts of Northumberland and Durham. A grant of £10,000 over five years on a diminishing scale has been promised to the National Association for Mental Health to establish and maintain a regional office in Leeds.

* Carnegie United Kingdom Trust. Fortieth Annual Report, 1953. Pp. viii+36. (Glasgow: Royal Technical College, 1954.)

ANALYSIS OF THE 1953 STORM SURGE IN THE NORTH SEA

AN analysis of the storm surge of the night of January 31–February 1, 1953, which caused the disastrous floods in eastern England and Holland, has been published by J. R. Rossiter (*Phil. Trans. Roy. Soc.*, **A, 246**, 371; 1954). Using tide-gauge data from thirty-three stations around the North Sea, he has eliminated the tidal rise and fall by the methods developed by A. T. Doodson and R. H. Corkan, and has constructed diagrams and charts showing the disturbance of sea-level at three-hourly intervals from 09.00 hr. on January 31 to 03.00 hr. on February 2. The meteorological conditions are shown by a similar series of charts, and from the two it is possible to follow the development of the surge.

The peak of the disturbance was greatest between East Anglia and the mouths of the Scheldt, where the water rose to between 9 and 11 ft. above the predicted levels, and in many places this occurred very near the time of high water. In the extreme south of the region the levels would, no doubt, have been even higher if some of the water had not been able to escape through the Strait of Dover into the English Channel. At the time of maximum disturbance, the mean level of the whole North Sea was raised by 2·2 ft., corresponding to the influx of 15 billion cu. ft. of water from the north. The effect of the earth's rotation was apparent in causing the incoming wave of the surge to be higher on the east coast of Britain, while the outgoing wave was higher on the continental side of the North Sea.

Mr. Rossiter has applied the method devised by R. H. Corkan for predicting the surge at Southend, and found that the initial rise and first peak were predicted fairly accurately; but the subsequent course of the surge was about 2 ft. lower than predicted, owing possibly to insufficient allowance being made for the escape of water through the Strait of Dover. After reviewing previous attempts to predict storm surge effects, he suggests several possible improvements in the methods of prediction. The 1953 surge appears to have been caused directly by the northerly winds in and immediately to the north of the North Sea, and there is no evidence of any appreciable external surge component, coming in from the Atlantic, which was a feature of some previous surges.

VELOCITY DISTRIBUTION OF SPORADIC METEORS

IN a paper entitled "The Velocity Distribution of Sporadic Meteors, IV: Extension to Magnitude + 8, and Final Conclusions"[1], Mary Almond, J. G. Davies and Prof. A. C. B. Lovell conclude their work on the velocity distribution of 1,095 sporadic meteors. The earlier papers on this subject have been briefly discussed in *Nature*[2], and the present paper gives a brief summary of the work and apparatus. Previous research on the brighter sporadic meteors gave no indication of an appreciable number with hyperbolic velocity, and now, extending the work to faint meteors of magnitude 8, the same results are obtained. Far from moving in hyperbolic orbits, it was found that nearly 90 per cent of all sporadic meteors must be moving in elliptical orbits with periods of about

two years, and the remaining 10 per cent had velocities close to the parabolic limit.

The work of Hoffmeister and Öpik was largely responsible for the belief, which prevailed for some time, that most of the sporadic meteors moved in hyperbolic orbits, although ten years ago Porter had criticized the methods used in the Arizona Meteor Expedition and had come to the conclusion that hyperbolic orbits were relatively scarce—if, indeed, they existed[2]. Although the work at Jodrell Bank Experimental Station of the University of Manchester has vindicated Porter's views, it is admitted that "the results do not exclude the possibility that less than 1 per cent may have hyperbolic velocities—a result which may imply an interstellar origin or may equally well be explained on the basis of perturbation within the solar system". Even if this should be verified in future years, there would still remain a very wide difference between meteors which have speeds just above parabolic velocity and those with high hyperbolic velocities, many more than 160 km./sec., which were found in the Arizona Meteor Expedition.

The conclusions attained by Hoffmeister were based on studies of the diurnal and annual variation of numbers of meteors, and it is interesting to know that in a private communication to Prof. Lovell he has shown how his observations can be reconciled with the more recent results of the survey of sporadic radiants by Prentice and by radio-echo measurements by Lovell. McKinley's results from radio echoes at Ottawa[4] are in good agreement with those obtained at Jodrell Bank, and all those who took part in this important programme must be congratulated on their perseverance and on the important results obtained. These have established practically beyond doubt that hyperbolic meteors, except in cases of perturbations by other bodies in the solar system, are extremely rare or possibly non-existent.

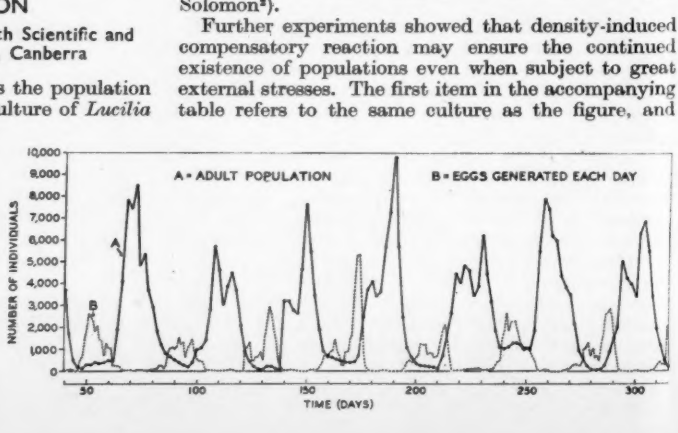
[1] *Mon. Not. Roy. Astro. Soc.*, **113**, 4 (1953).
[2] *Nature*, **169**, 962 (1952); **170**, 872 (1952); **172**, 751 (1953).
[3] *Mon. Not. Roy. Astro. Soc.*, **104**, 257 (1944).
[4] *Astrophys. J.*, **113**, 225 (1951).

EXPERIMENTAL DEMONSTRATIONS OF BALANCE IN POPULATIONS

By Dr. A. J. NICHOLSON

Division of Entomology, Commonwealth Scientific and Industrial Research Organization, Canberra

THE accompanying graph records the population changes which took place in a culture of *Lucilia cuprina* Wied. held constantly at 25° C. and provided with ground liver for the adults at the constant rate of 0·5 gm. per day. The other consumable requisites, namely, meat for the larvæ (from which the adults were excluded) and water and sugar for the adults, were provided in excess each day. As adults live at least as long when supplied with adequate water and sugar as they do when given protein food also, and as protein food is necessary for egg production, the population was automatically regulated by the effects produced upon egg production by adult competition for the restricted supply of ground liver.



The graph clearly shows an inverse relation between the numbers of adults and the numbers of eggs laid. When the adult population was large, competition for the limited supply of ground liver was so severe that few, if any, adults obtained sufficient for egg production, whereas when the population was small, many obtained adequate supplies and so laid eggs freely. The bimodal form of the egg-generation curves was due to the fact that the population consisted of senile individuals as it approached a minimum, and dominantly of young and vigorous individuals immediately afterwards.

Thus low populations induced the rapid generation of new individuals, whereas high populations suppressed reproduction and so dwindled, with little or no replacement of the individuals that died. Such corrective reaction would have counteracted any departure from the equilibrium density (at which eggs are produced at just the replacement-rate) had there not been a lag of about two weeks between the deposition of eggs and the emergence of the resulting adult flies. This lag between the initiation and operation of reaction produced a violent and sustained oscillation in the population about its equilibrium density, the mechanism being essentially similar to that already described[1] for populations of *L. cuprina* competing for larval food. Although the oscillations resulted from the great disparity existing between the number of births and the number of deaths at almost all times, examination of the data showed that, on the average over a number of complete oscillations, these numbers were virtually equal. It is clear, therefore, that density-induced reaction held the population in a state of balance in its environment.

'Balance' as here used may be defined as a sustained state of corrective reaction to disturbing forces which ensures the persistence of the system. This is normal usage, for it is precisely what we mean when we speak of the balance of a tight-rope walker, or of the balancing of a billiard cue vertically upon a responsive finger-tip. Although 'equilibrium' is one of the senses in which the word is sometimes used, there is no justification for restricting 'balance' to this particular meaning when it is used in relation to population problems, as some biologists do (for example, Solomon[3]).

Further experiments showed that density-induced compensatory reaction may ensure the continued existence of populations even when subject to great external stresses. The first item in the accompanying table refers to the same culture as the figure, and

	Imposed destruction of emerging adults (per cent)	Mean number of eggs laid per day	Mean number of adults emerged per day	Mean adult population
Adult competition	0	624	573	2,520
	50	782	712	2,335
	75	948	878	1,588
	90	1,361	1,260	878
Larval competition	0	8,794	157	1,252
	75	4,121	192	464
	95	1,921	437	249
	99	1,330	909	128

the next three refer to cultures similar in all respects except that a constant percentage of all emerging adults was destroyed in each. The last four items in the table refer to an otherwise similar group of cultures in which the populations were limited by the provision of only 50 gm. of meat for the larvæ in each culture each day. The adults were supplied with excess ground liver, and so could lay eggs freely at all times. In essentials the culture referred to in the fifth item was similar to one previously illustrated[1], and its population oscillated in density with similar violence. All these cultures maintained a state of balance with their environments. Their population patterns were similar to that in the figure, except that the violence of the sustained oscillations decreased with increasing percentages of destruction.

In the first group of cultures the destruction of emerging adults reduced competition, and so permitted a greater number of the surviving individuals to obtain sufficient ground liver to lay eggs; and in the second group the smaller number of eggs laid by the reduced adult population permitted a greater number of the competing larvæ to obtain sufficient meat to mature. Consequently in both groups density-governed reaction to increased destruction caused more individuals to emerge on the average each day, as is shown in the table. This in turn caused the reduction of the adult population to be markedly less than the degree of destruction imposed.

In experiments in which other life-stages of *L. cuprina* were destroyed, the same tendency for the immediate effects of destruction to be counteracted by compensatory reaction was observed. Invariably reaction caused more individuals to reach the stage subject to destruction, which in turn caused the densities of some life-stages of the insects to be increased, and those of other stages to be decreased. In general character these results parallel the conclusions reached theoretically in earlier investigations[3,4] concerning the effects produced by a new destructive factor upon a host population which is governed by the reaction of a specific parasite.

These and other experiments are discussed in greater detail in two articles[5] which will be published shortly. In one of these it is shown that compensatory reaction to density change is a feature of all kinds of stable population systems, and that it is dominantly responsible for the regulation of populations of all kinds of animals. It is also shown that compensatory reaction is a necessary counterpart of natural selection. Selection by itself merely favours the preservation of the fitter individuals; but compensatory reaction automatically performs the necessary evolutionary function of eliminating the less-fit individuals, even though these may be so well adapted that their kind would have persisted indefinitely had the fitter individuals not been present. General arguments leading to this conclusion were given in earlier articles[3,6]; but the experiments with *L. cuprina* demonstrate the actual existence of the mechanism there postulated.

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MECHANISM OF ANIONOTROPY*

By Dr. E. A. BRAUDE, D. W. TURNER and Dr. E. S. WAIGHT

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THREE principal mechanisms, which may be labelled unimolecular, bimolecular and intramolecular, have been considered for anionotropic changes[1]. Allylic systems, in particular, have received much attention, and although the existence of all three mechanisms now appears to be conceded by most workers in this field, opinions differ in regard to the extent of their incidence.

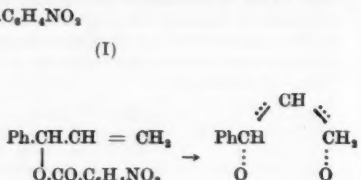
The unimolecular ionization theory of anionotropy[2,3], which postulates reversible dissociation to give 'kinetically free' anions and carbonium-ions and represents the forerunner of the more general hypothesis of unimolecular nucleophilic substitution, was originally based on the results obtained by Burton[2] in a study of the rearrangement of 1-phenylallyl-*p*-nitrobenzoate (I) to cinnamyl *p*-nitrobenzoate (II). In view of the strong electron-attracting properties of the carbonyl and nitro-groups, a *p*-nitrobenzoate ester certainly represents a relatively favourable case for the occurrence of mechanism (1).

We have re-investigated this reaction in both aqueous and non-aqueous solvents, following the isomerization by the spectrokinetic technique (in ethanol, (I) shows $\lambda_{max.}$ 2565 A., ε 13,800, whereas (II) shows λ_{max} 2535 A., ε 30,700). It soon became apparent that in non-aqueous solvents—for example, in chlorobenzene at 130°—the 'spontaneous' rate of rearrangement was greatly dependent on the method of purification of the ester and of the solvent, and that the reaction is accompanied by the formation of small amounts of *p*-nitrobenzoic acid which could be extracted with water and estimated titrimetrically with ammonia or polarographically, using a platinum microelectrode (Fig. 1). The production of *p*-nitrobenzoic acid had been previously noticed by Meisenheimer[4], who also reported that the addition of acid had little effect on the reaction. We find, on the contrary, that the rearrangement is greatly accelerated by *p*-nitrobenzoic acid, and that its rate is very nearly proportional to the concentration of acid above c. 0·01 *M* (Fig. 2, curve 1). At extremely low concentrations of acid, however, the first-order rate constants approach a small, limiting value indicating a residual, non-catalytic rate, which is much smaller than that recorded qualitatively by Burton[2]. This

* Substance of a paper read at a symposium on "Molecular Rearrangements in Organic Chemistry", held at Queen Mary College, London, on April 6.

$$\underset{\text{O.CO.C}_6\text{H}_4\text{NO}_2}{\text{Ph—CH—CH=CH}_2} \rightleftharpoons [\text{PhCH}\cdots\text{CH}\cdots\text{CH}_2]^+ + \text{NO}_2\text{C}_6\text{H}_4\text{CO}_2^- \rightarrow \underset{\text{O.CO.C}_6\text{H}_4\text{NO}_2}{\text{Ph—CH=CH—CH}_2} \quad (1)$$

(I) (II)



(2)

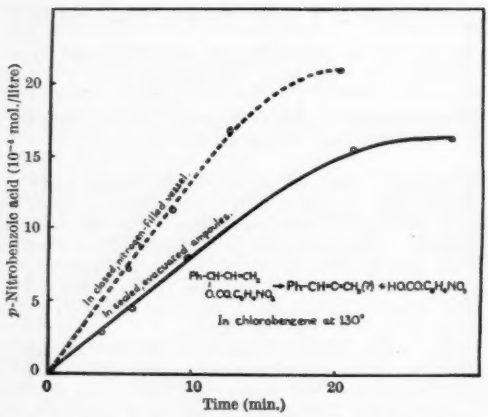


Fig. 1. Elimination of *p*-nitrobenzoic acid from 1-phenylallyl *p*-nitrobenzoate (0·18 *M*) in chlorobenzene at 130° in sealed 'Pyrex' glass ampoules (——) and in an unsealed vessel under nitrogen (- - - -)

part of the curve can only be reached by working under rigorously controlled conditions, with complete exclusion of moisture and acidic impurities. Under these conditions, the first-order rate constants exhibit an upward drift as the reaction proceeds, evidently due to the catalytic effect of the *p*-nitrobenzoic acid produced in the side-reaction. The degree of preference for the catalytic mode of rearrangement is indicated by the fact that its specific rate constant in the presence of *p*-nitrobenzoic acid is greater by a factor of about 100 than that of the uncatalysed rearrangement.

We believe that these experiments constitute the first demonstration of truly thermal rearrangement of an allylic ester in solution. (We have never held the view, ascribed to us by Ingold[5] and Hughes[6], that allylic esters will rearrange only in the presence of acids. Our contention, here confirmed, has been that uncatalysed rearrangement is difficult to observe because it is usually swamped by much more facile catalytic processes; see ref. 7.) If the uncatalysed reaction proceeded by mechanism (1), the intermediate carbonium-ions could recombine with partners other than the original *p*-nitrobenzoate ions, that is, the isomerization would be intermolecular. The simplest alternative is intramolecular rearrangement, as represented in (2).

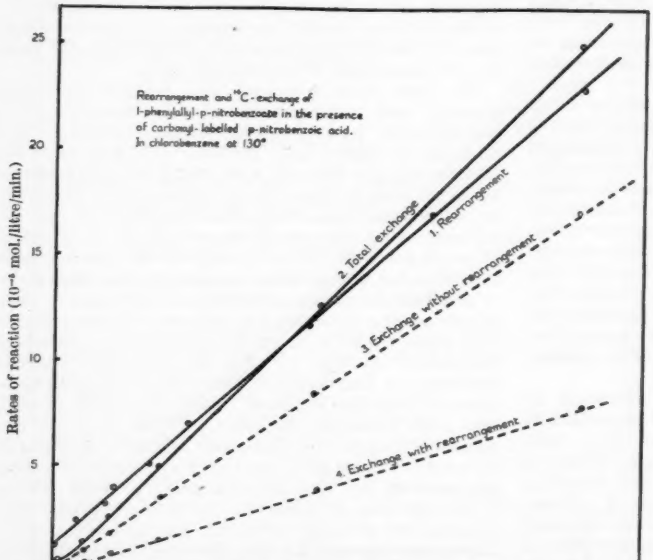
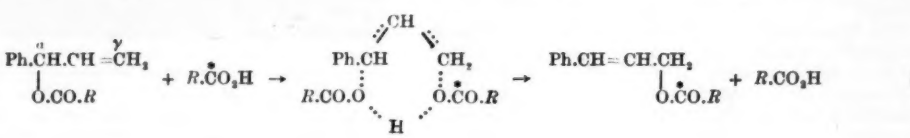


Fig. 2

We have studied the rearrangement in the presence of ^{14}C-carboxyl-labelled *p*-nitrobenzoic acid as a source of *p*-nitrobenzoate ions. (The acid was prepared by the interaction of *p*-bromonitrobenzene and K^{14}CN in dry pyridine to give *p*-cyanonitrobenzene, followed by hydrolysis.) The fate of the labelled *p*-nitrobenzoyl group was determined by separating the acid and the two esters at various stages and measuring their specific radioactivity in dimethylformamide solution, using a methane-flow proportional counter. The most significant result is that, at low acid concentrations, the rate of exchange is much less than the rate of rearrangement. This indicates that the uncatalysed, 'spontaneous' rearrangement is intramolecular. Intramolecular anionotropic rearrangement has previously been demonstrated in structurally and environmentally less favourable systems[7-9], and it would indeed be most surprising if any other reaction path were followed in the present instance. Why should

a molecule undergo the drastic, energy-consuming step of complete ionization, when it can redistribute its electrons by an internal, synchronized process involving a six-membered cyclic transition state? So far as this particular case, at least, is concerned, the unimolecular ionization theory must surely now be abandoned.

At higher *p*-nitrobenzoic acid concentrations the total rate of exchange rapidly increases (Fig. 2). The larger part of the exchange reaction takes place without rearrangement and must be due to bimolecular substitution by *p*-nitrobenzoic acid or *p*-nitrobenzoate ion at the α-carbon atom. This is analogous to neutral or alkaline hydrolysis in aqueous media, which also proceeds without rearrangement, contrary to the findings of Kenyon, Partridge and Phillips[8]. The smaller part of the exchange reaction takes place with rearrangement, and the difference between curves 1 and 4 (Fig. 2) represents the contribution of the intramolecular isomerization. The acid-catalysed, intermolecular rearrangement which is represented by curve 4 is evidently bimolecular and may proceed by direct attack of undissociated acid molecules at the ethylenic γ-carbon atom of the ester, through a cyclic transition state involving a hydrogen bridge (R=*p*-$NO_2.C_6H_4$—):



Alternatively, proton-transfer to the ester to give the oxonium-ion, in which the existing alkyl–oxygen bond is weakened, may precede bimolecular attack, as in aqueous solvents[1]. We cannot yet distinguish between these two versions, partly because nothing is known about the ionization equilibria of *p*-nitrobenzoic acid in chlorobenzene, and further investigations, including acidity-function measurements, are in progress.

The non-participation of 'foreign' *anions* in the rearrangement of 1-phenylallyl *p*-nitrobenzoate is easily shown in the case of bromide ions by the fact that no cinnamyl bromide is formed when the reaction is carried out in the presence of di*iso*amylammonium bromide. Burton[3] sought to demonstrate the participation of acetate ions by heating 1-phenylallyl *p*-nitrobenzoate with acetic anhydride and tetramethylammonium acetate and isolating cinnamyl acetate. However, since reagent-grade acetic anhydride contains acetic acid, and since the two known procedures for the preparation of tetramethylammonium acetate give products which contain acetic acid or water of crystallization[10], there is little doubt that in Burton's experiments the rearrangement was taking place in the presence of acetic acid. Burton states, without details, that 1-phenylallyl *p*-nitrobenzoate could be "left for some months without change in solution in acetic acid, acetic acid containing a few drops of 30% hydrobromic acid and alcoholic hydrochloric acid", but we have found that rearrangement takes place quite rapidly under such conditions. Viewed in this light, Burton's experiments no longer provide evidence for the participation of acetate anions, and, without dogmatizing before further investigation as to what happens in the solvent acetic anhydride, the result obtained with tetramethylammonium acetate can be interpreted as due to bimolecular γ-substitution by acetic acid, analogous to the intermolecular rearrangement which occurs in chlorobenzene in the presence of *p*-nitrobenzoic acid.

The present results thus support the view[1,7,11,12] that the rearrangement of allylic alcohols and esters is normally bimolecular, or, in special cases, intramolecular. Bimolecular, non-isomeric rearrangement has also been demonstrated by Kepner, Winstein and Young[13], and others[14,15], in allylic halides. Ingold and his associates[3,5] have adduced reasons why bimolecular rearrangement (which they term S_N2') should be rare. One of us[1] has pointed out, however, that although bimolecular attack by charged *anions* at the ethylenic γ-carbon atom will be impeded by the electrostatic repulsion due to the unsaturation electrons, attack by *neutral molecules* (for example, H_2O, ROH, RCO_2H, NR_3, etc.) will be far less subject to such an effect. It should also be remembered that intramolecular and bimolecular mechanisms (for example, equations 2 and 3) on one hand, and unimolecular mechanisms (for example, equation 1) on the other, represent extremes of a continuous range of possible time-sequences. It is quite conceivable that in mechanism (2), for example, the intermediate stage possesses some ion-pair character. Similarly, in mechanism (3), bond-breaking at C_α may be slightly ahead of bond-making at C_γ; this will leave the whole process essentially synchronized, and the electron displacements will be assisted by the unshared electron pair on the oxygen atom being joined to C_γ. Such a concept is entirely analogous to that of 'hybrid' mechanisms in nucleophilic substitution[16–18].

We are much indebted to Prof. R. P. Linstead for providing us with the facilities for work with radioactive tracers. We also thank the Department of Scientific and Industrial Research for a maintenance grant to one of us (E. S. W.) during 1948–50.

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LETTERS TO THE EDITORS

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An Unusual Virus Disease of a Dipterous Larva

An apparent nuclear disease of the larva of the crane fly, *Tipula paludosa*, was briefly described in 1923 by Rennie[1]. We have now rediscovered this disease, which seems to be infectious, and have compared it to some extent with the nuclear and cytoplasmic polyhedroses of lepidopterous larvæ, from which it differs in some important respects.

In the nuclear polyhedral diseases of lepidopterous larvæ, virus rods arise in the chromatic masses of infected nuclei[2], and are liberated into the clear nuclear ring zone where the polyhedral protein also accumulates. Crystalline polyhedra form in which the virus rods, *c.* 300 mμ × 40 mμ, are embedded. This type of polyhedra becomes surrounded by a membrane. In dilute sodium carbonate the polyhedra swell slightly, and, with few exceptions, dissolve readily, freeing the virus rods contained within.

The cytoplasmic polyhedra of the gut contain spherical virus particles[3]. In a paper now in the press[4] we have demonstrated, in the case of the larva of the angleshades moth, *Phlogophora meticulosa*, the interesting fact that the virus particles are composite in nature. The virus bodies are embedded in a matrix of polyhedral protein and measure about 60 mμ in diameter. Each consists of four or five smaller spheres, approximately 12 mμ in diameter. During the course of the disease the small spheres apparently arise first in the cytoplasm and secondarily associate into the larger bodies prior to the formation of the polyhedra. The minimal infectious unit may well be the small particles of 12 mμ diameter. The cytoplasmic polyhedra also dissolve in weak alkali, but partially and in a different manner from the nuclear type. The larger virus bodies readily dissociate into their small component spheres which, on account of their small size, are easily overlooked.

In the polyhedrosis of *Tipula*, a chromatic mass forms in the enlarged nuclei of the blood cells, and from this mass the chromatic material segregates as several spherical bodies, leaving a large eosinophile body in the nucleus; the polyhedra seem to arise around the periphery and are closely applied to the nuclear membrane (Fig. 1). They differ in appearance and may be rectangular or shaped like a segment of an orange. They are negatively birefringent and appear to be genuine crystals. Their behaviour in the presence of different reagents is most unusual and differentiates them sharply from either of the other groups of polyhedra. They are resistant to trypsin and to dilute and weak acids and alkalis. In 1 *N* sodium hydroxide they elongate to six or more times their length, becoming first biconvex spindles and then elongating into crescents or worm-like shapes (Fig. 2). At about three times their normal length this elongation is still completely reversible, and in water, at *p*H 5–8, they return to their original size and shape. After such treatment, however, the polyhedra are 'activated'; in other words, they now respond in a similar manner in ammonia, 1–12 per cent sodium carbonate and hydrochloric acid, *p*H 1–4, but not to 1 *N* hydrochloric acid or 25 per cent sodium carbonate. The elongation and contraction or return to normal shape, which take place along the same axis, can be repeated indefinitely in these solutions and take place as rapidly as the solutions can be alternated.

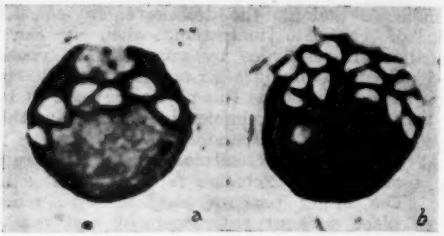

Fig. 1. Blood cells from an infected larva of *Tipula paludosa*, showing the polyhedral crystals. × 1,500

The polyhedra are not usually dissolved even after half an hour in 1 *N* sodium hydroxide at 20° C. In a solution of equal parts of 1 *N* sodium hydroxide and 1 *N* potassium cyanide, the response is speeded up enormously and the polyhedra elongate even further to reach their maximum in 1½ min. They dissolve completely in 2–4 min. The polyhedra give a positive reaction with xanthoproteic and ninhydrin tests, and stain with bromophenol blue after treatment for 15 min. with 1 *N* hydrochloric acid at 60° C. Their substance is Feulgen-positive throughout, and each polyhedron has intensely staining granular bands at about ½ μ intervals. Tests for sulphur have been negative.

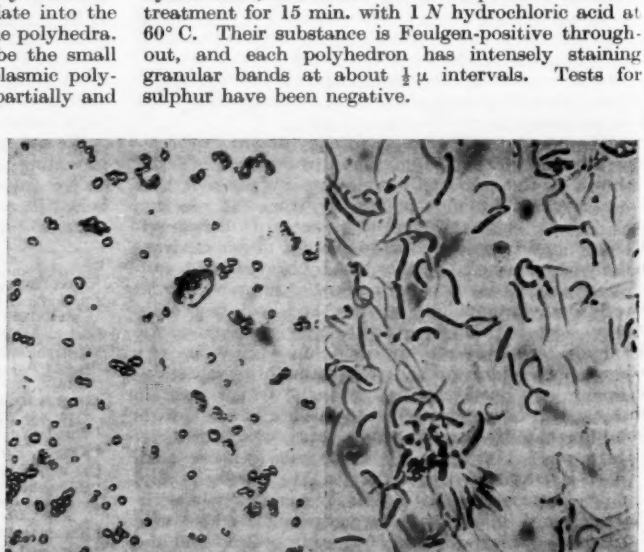

Fig. 2. On left, untreated polyhedra; on right, the same after treatment with ¼*N* sodium hydroxide and ¼*N* potassium cyanide for 90 sec. × 200

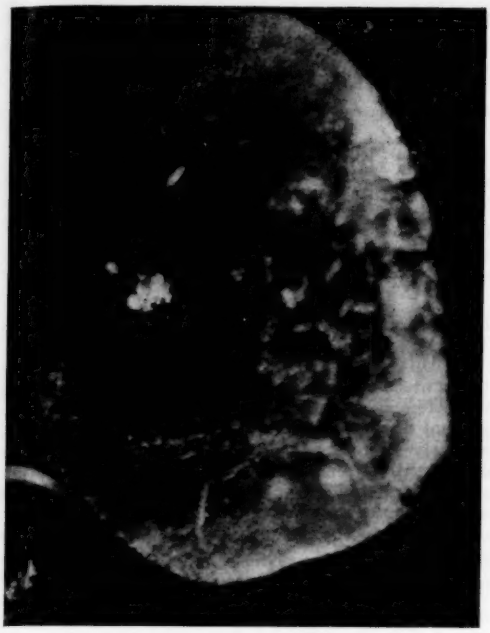

Fig. 3. 'Ghost' of a polyhedral crystal after treatment for 4 min. with 1 *N* sodium hydroxide, 1 min. 0·5 *N* sodium thioglycollate (*p*H 8·4) and 1 min. 1 *N* sodium hydroxide. Note the apparent virus rods. × 14,700

In such resistant polyhedra as these, it is a difficult matter to observe any possible virus bodies within. However, we have made studies, on the electron microscope, of polyhedra subjected to various treatments. In one, the polyhedra were exposed to 1 *N* sodium hydroxide and washed. The resulting elongated forms appeared semi-opaque with a granular and fibrous structure. In another series the polyhedra were treated with 1 *N* sodium hydroxide for 4 min., then washed and treated with sodium thioglycollate at *p*H 8·4 for 4 min., and finally washed and treated for one minute with 1 *N* sodium hydroxide. Under this treatment, most of the substance of the polyhedral crystal is dissolved, leaving behind a lens-shaped 'ghost'. In many polyhedra treated in this fashion we have observed rod-shaped bodies which could be virus rods (Fig. 3).

Acknowledgments are due to Mr. H. C. F. Newton and Miss Margaret Megaw, of the National Agricultural Advisory Service at Wolverhampton, who sent us the batch of larvæ in which the first diseased specimen was found, to Dr. Max Perutz for his determination of the negative birefringence of the crystals, and to Miss Elizabeth Green, of the Cavendish Laboratory, who took the electron micrograph.

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N. Xeros

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Molteno Institute, Cambridge.
March 16.

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Form of Myelinated Nerve Fibres

D'Arcy Thompson[1] directed attention to the fact that the shape of a liquid body may be regarded as a 'diagram of forces' acting on it at the moment. As the myelinated nerve fibre is a liquid thread enclosed in a distensible and elastic[2] neurilemmal tube, it was thought that a thorough determination of its shape might help to reveal some of the forces maintaining the structure and organization of the fibre.

It is essential for the determination of the shape to make measurements on living fibres in which the physical state of axoplasm and myelin remains unaltered and the proportions of different regions are as undistorted as possible. Carefully teased preparations of unstained fibres were used for this purpose. When the teased fibres are allowed to float freely in a chamber some 100–200 μ deep instead of being simply spread out between slide and coverslip, their deterioration is greatly delayed and the shape of the fibres remains unchanged for many hours. The dimensions observed in such conditions presumably do not deviate markedly from those of the fibres in normal physiological surroundings.

The nerve fibre, which is approximately cylindrical along the internodes, presents, as was noticed by Ranvier[3], small bulbous enlargements on both sides of the nodes. These enlargements are not symmetrical. One of them is always more bulky and longer than the other[4] (Fig. 1). In marking the original direction of the nerve at the removal from the body, it was found that the larger bulb is always situated on the proximal side of the node in mixed as well as in purely sensory nerves.

In order to test whether the asymmetry of the bulbs is not an artefact due to the direction of teasing, the nerves were teased in opposite directions

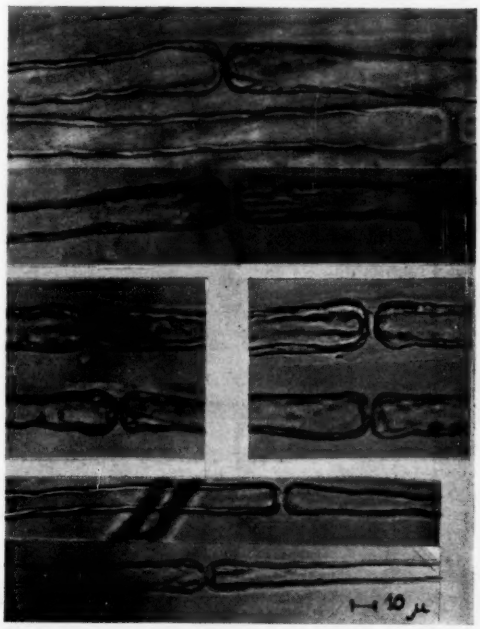

Fig. 1. Photomicrographs of nodes of Ranvier in cat peripheral nerve fibres. Proximal bulbs on the left

Table 1. Mean Values and Confidence Limits (*t*-test) at 5 per cent Level of Probability of Several Dimensions of the Juxtanodal Regions in Cat Nerve Fibres (in microns)

Mean internodal diam. A	Maximal diam. of bulbs Proximal P_1	Maximal diam. of bulbs Distal D_1	Diam. of bulbs at a distance of one internodal width from the maximal diam. Proximal P_2	Diam. of bulbs at a distance of one internodal width from the maximal diam. Distal D_2	Distance between node and max. diam. of bulb Proximal P_3	Distance between node and max. diam. of bulb Distal D_3	Diam. of node C	No. of nodes
6·2	8·35 ± 0·20	7·83 ± 0·23	7·25 ± 0·23	6·83 ± 0·15	7·56 ± 0·39	7·15 ± 0·60	4·27 ± 0·18	61
8·0	11·24 ± 0·30	10·53 ± 0·32	9·83 ± 0·30	9·18 ± 0·27	8·19 ± 0·46	7·56 ± 0·50	5·33 ± 0·25	69
10·0	13·65 ± 0·31	12·64 ± 0·36	12·07 ± 0·28	10·63 ± 0·24	9·61 ± 0·73	7·76 ± 0·55	6·79 ± 0·31	65
12·0	15·80 ± 0·30	14·89 ± 0·27	14·29 ± 0·22	12·98 ± 0·27	10·52 ± 0·62	8·99 ± 0·73	7·53 ± 0·27	57
14·0	18·23 ± 0·31	16·99 ± 0·29	16·23 ± 0·30	14·83 ± 0·30	11·35 ± 0·56	9·52 ± 0·63	8·42 ± 0·29	58
16·0	20·09 ± 0·34	18·68 ± 0·29	17·85 ± 0·31	16·39 ± 0·27	12·09 ± 1·02	10·06 ± 0·62	8·65 ± 0·34	51
17·6	21·51 ± 0·26	20·30 ± 0·40	19·31 ± 0·41	17·87 ± 0·35	12·70 ± 1·23	9·48 ± 0·89	9·75 ± 0·38	28
19·5	23·91 ± 0·38	22·58 ± 0·33	21·34 ± 0·31	20·01 ± 0·37	13·47 ± 1·62	10·46 ± 0·85	9·77 ± 0·53	40

in two sets of experiments. No influence of the direction of teasing could be detected during examination of some six hundred nodes. A bulb situated centrally was larger in fibres teased in both directions.

The inequality of juxtanodal bulbs was observed in peripheral fibres of mice, rats, guinea pigs, rabbits, cats, dogs and frogs. The general occurrence of this phenomenon suggests that the polarity of the bulbs may be a reflexion of some fundamental process going on in all myelinated nerve fibres and merits a closer quantitative analysis. This was carried out on fibres from cat peripheral nerves. The dimensions chosen to determine the shape of the juxtanodal region of the fibre, and allowing for calculation of volumes, are shown in Fig. 2. The mean diameter of the fibre was determined from six measurements taken along the internodes adjacent to the nodal region examined. The results of measurements of more than four hundred nodes were grouped by internodal diameter classes, and mean values and confidence limits of each dimension are presented in Table 1.

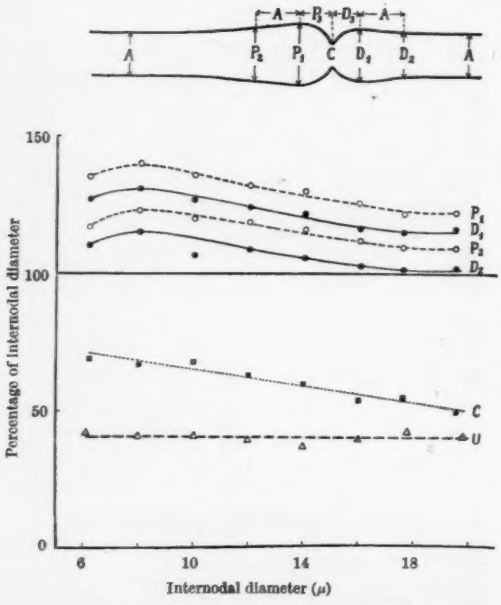

Fig. 2. Relative dimensions in the nodal region of cat peripheral fibres as a percentage of the mean diameter of the internode. The diagram indicates which dimension each of the upper curves refers to: A, mean diameter of the internode; U, unstretched diameter of the neurilemmal tube; P, proximal bulb; D, distal bulb; C, diameter of the node

It will be seen that the diameters of the proximal bulbs are consistently larger than the corresponding diameters of the distal bulbs. The scatter of longitudinal dimensions is larger than that of diameters, and the difference between P_3 and D_3 is not significant for smaller fibre groups. The calculation of bulbar volumes based on these data reveals a net surplus of material in the proximal bulbs, amounting to 100–2,000 μ^3, according to the fibre size.

Fig. 2 shows the relative width of characteristic parts of the nodal region as a percentage of the mean diameter of the internode in fibres ranging from 5 to 20 μ in diameter. It was shown previously on rabbit nerves that the neurilemmal tube, relatively inextensible in the nodes, is distensible and elastic over the internodes, and is actually distended by the fibre contents. The normal width of the fibres is determined by an equilibrium between the turgor pressure of the axoplasm and the elastic tension of the neurilemma. In order to evaluate the normal degree of distension of the internodal neurilemma in cat fibres, the excess of material was removed from a limited portion of the fibres by local application of external pressure. Under a gradually increasing external pressure, the fibres in the compressed part contract progressively but preserve their cylindrical outline. When the external pressure exceeds a certain critical value, the fibres become flattened and entirely emptied of their contents. By keeping the external pressure just below the critical value, the 'unstretched' diameter of the nerve tube is obtained. It was measured in 265 fibres and the results, grouped by normal fibre size and calculated as a percentage of the mean normal diameter of the internode, form the lowest curve in Fig. 2. It will be noted that the unstretched diameter amounts to about 40 per cent of the normal diameter in fibres of all sizes. This means that the internodal portions of neurilemmal tubes are distended by the pressure of axoplasm in the same proportions in all fibres. The degree of distension of the bulbar region depends on the diameter of the fibres and decreases with increasing diameter except for the smallest and the largest fibre groups.

Although a full interpretation of the form of the fibres requires further experiments, their morphological polarity seems to provide an additional confirmation of the existence of a proximo-distal flow of axoplasm in the axon. The nodal part of the nerve tube, narrower and less extensible than its internodal portion, creates a resistance to the flow and leads to piling up of material above the node. The situation resembles closely that created artificially by Weiss[5] in experiments with apposition of a con-

stricting sleeve on the nerve. The morphological result is also similar in both cases.

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Observations on Experimental Anthrax: Demonstration of a Specific Lethal Factor produced *in vivo* by *Bacillus anthracis*

An enigma in the study of the cause of death in anthrax has been that no lethal endo- or exo-toxin has been found in cultures of the organism[1–3]. Recently, we have been able to demonstrate a factor in the plasma of guinea pigs dying of anthrax which is not only lethal but also specifically neutralized by anthrax antiserum. This communication describes briefly work which has led to this finding. A fuller report will be published elsewhere.

In previous studies[4–6], a mixture of the plasma (approximately 1 part) and peritoneal and thoracic exudates (approximately 5 parts) was collected from guinea pigs dying of anthrax for studies of the chemical basis of the virulence of *B. anthracis*. It was shown that large volumes of this plasma-exudate and extracts of the organisms separated from it were non-lethal to guinea pigs when injected intraperitoneally. The conclusion was reached that the products of *B. anthracis* growing *in vivo* were not markedly toxic. This agreed with the fact that large numbers (approximately 1×10^9 chains per ml.) grew in the blood of a guinea pig before death resulted. It was suggested that death followed the action of harmful effects which were weak, relative to the number of organisms producing them. One such effect was the slight tissue-damaging activity shown in this and previous work[2,7].

Attention then turned to the significance of the massive terminal bacteræmia in the death of normal guinea pigs. This topic was important in view of reports[9,10] that some animals of other species die of anthrax without a marked bacteræmia. Guinea pigs (700 gm.) were infected intradermally with *B. anthracis* (strain *N.P.*). On the third day, and in the twelve hours preceding death, the number of organisms in the blood rose from $0{\cdot}2–0{\cdot}4 \times 10^6$ to $0{\cdot}5–1{\cdot}0 \times 10^9$ chains per ml. There was a remarkably constant relationship between the bacterial count of the blood and the interval before the host's death. The administration of streptomycin abruptly terminated the bacteræmia, and provided the latter had not increased beyond 3×10^6 per ml., the animals were saved (20/23 with $0{\cdot}7–1{\cdot}5 \times 10^6$ per ml. of blood). All guinea pigs having a bacteræmia greater than the critical level (47/47 with $0{\cdot}7–1{\cdot}5 \times 10^7$ per ml.) died 1–3 days later, although free from active infection. These experiments showed conclusively that a bacteræmia appeared to be an essential factor for death, but the fate of the guinea pig was determined when the blood-stream invasion had reached only 1/300 of its maximum. This finding almost certainly renders untenable the views that death from anthrax might be due to mechanical blockage by the organisms or to a deficiency in the host of oxygen, etc.

An insight into the probable nature of the lethal product of *B. anthracis* was provided by chemical examination of the blood, histological examinations and clinical observations on guinea pigs at their death, both from active infection and later, after this had been removed by streptomycin. A raised hæmatocrit and total blood nitrogen, lowered plasma protein, the presence of anuria, delayed clotting of blood, terminal collapse with subnormal temperatures 85°–89° F. and histological and chemical evidence of acute nephrosis were noted. These observations and others as yet incomplete provided sufficient evidence for a working hypothesis that the animals died 'in shock'[11]. This agrees with the known œdematous and hæmorrhagic nature of anthrax and with the fact that guinea pigs, which die two to three days after the bacteræmia has been stopped by streptomycin, have acute renal failure (plasma constituents were: protein nitrogen, 373; non-protein nitrogen, 179; urea, 311; phosphorus as inorganic phosphate, 18; and calcium, 7·5 mgm. per 100 ml.; presence of anuria and severe nephrosis).

This evidence emphasized the importance of an œdema-producing factor. We therefore re-examined the distribution and activity of the tissue-damaging factor. Filtered heparinized plasma from guinea pigs dying of anthrax (strain *N.P.*) was much stronger in this respect than the plasma-exudate formerly used[6]. Plasma (0·2 ml.), when injected intradermally into test guinea pigs, produced an extensive area of œdema and congestion (40 mm.), and a positive reaction still resulted from a dilution of 1/25 of the material.

Table 1. Specific Lethal Effect of Plasma from Guinea Pigs dying of Anthrax

Anthrax plasma injected (vol. in ml.)	Mice (18–22 gm.) (Figures show the number of deaths in batches of 5 mice)												Guinea pigs (250 gm.) (number dead / number treated)			
	Intravenously						Intraperitoneally						Intravenously			Intraperitoneally
	1·0	1·0 + a.s.*	0·5	0·5 + a.s.	0·25	0·25 + a.s.	1·0	1·0 + a.s.	0·5	0·5 + a.s.	0·25	0·25 + a.s.	6	6 + a.s.	3	6
Batch 1	5	—	4	—	—	—	—	—	—	—	—	—	—	—	—	—
Batch 2	5	0	3	0	2	0	5	0	2	0	1	0	2/2	0/3	1/4	—
Batch 3	5	0	5	0	2	0	4	0	5	0	0	0	5/6	0/5	1/3	1/2
Batch 4	5	0	4	0	2	0	2	0	1	0	0	0	3/4	0/4	—	3/7
Total deaths %	100	Nil	80	Nil	40	Nil	73	Nil	53	Nil	7	Nil	83	Nil	28	44

* a.s. means that anti-anthrax horse serum (half to a third the volume of the plasma) was allowed to react with the anthrax guinea pig plasma at room temperature before injection.

Volumes of 1 ml. or greater were injected into mice in 0·5-ml. aliquots at several hour intervals.

Guinea pigs were injected into the jugular vein using a local anæsthetic.

Adequate control groups of mice and guinea pigs were injected with appropriate volumes of normal guinea pig plasma with the addition of lysed red cells (equivalent to the 10–15 per cent hæmolysis usual in the plasma of guinea pigs dying of anthrax). No deaths occurred.

Tests on samples of plasma taken at intervals during the bacteræmia showed that this tissue-damaging activity increased regularly with the increase in the numbers of organisms in the blood. Anthrax antiserum (horse; Weybridge spore vaccine; produced by our colleague, F. C. Belton) neutralized the skin reaction completely. When the peritoneal exudate was found to be low in tissue-damaging activity, an explanation was revealed for the relatively low activity of the mixture of plasma and exudate previously used. This had consisted largely of exudate.

The possibility of a specific lethal effect of the undiluted plasma was now investigated. Table 1 summarizes the results of four experiments with mice and guinea pigs injected intravenously and intraperitoneally with the plasma. The resulting deaths, coupled with the absence of deaths in control animals and in those receiving plasma mixed with the anthrax antiserum, shows clearly the lethal nature and specific character of the factor present in such plasma. A higher death-rate and a shorter survival-time indicated that the plasma was more effective intravenously than by the intraperitoneal route which had been used in previous studies[6]. Finally, animals dying in these experiments showed the same symptoms of œdema, collapse with subnormal temperatures, and of nephrosis as did infected animals.

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Phosphate Partition and Turnover in Human Red Cells

Phosphate partition and turnover in the human red cell can be studied by paper chromatography, which permits unequivocal separation of the organic phosphate compounds involved in carbohydrate metabolism.

In the following experiments, 20 ml. of heparinized whole blood was incubated at 37° C. with about 50 μc. of sodium dihydrogen phosphate (^{32}P) and samples removed after varying times, the whole system being kept mixed and at constant *p*H by the introduction of 95 per cent oxygen, 5 per cent carbon dioxide. The red cell samples were packed by centrifuging and washed twice with an isotonic phosphate buffer of *p*H 7·4 after removal of the buffy coat. All centrifuging was carried out at 2,500 *g* for 15 min. The cells were then hæmolysed with water and saponin, and the stromata separated by high-speed centrifuging after buffering the solution to *p*H 4·2 with an acetate buffer[1]. After removal of the supernatant fluid, the stromal fraction was further washed twice with the buffer. Trichloracetic acid extracts could then be made from both the stroma and intracellular contents of the cells and treated chromatographically in the manner described by Caldwell[2]. Location of individual spots was carried out with a scanning counter, and these were cut out and their radioactivities assayed by conventional methods. The total phosphorus in each spot was estimated by the method of Berenblum and Chain[3].

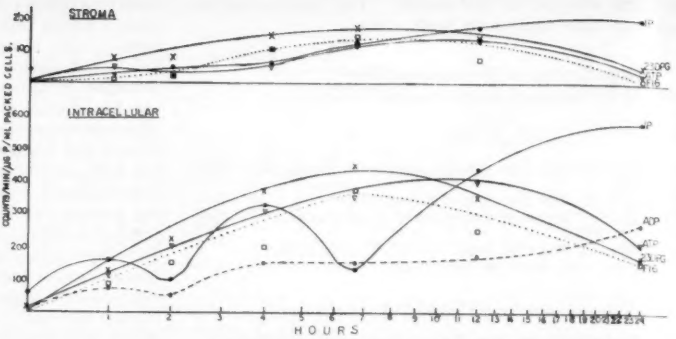

Fig. 1. Relative specific activity (counts/min./μgm. phosphorus/ml. packed cells) against time. Key to curves: *IP*, inorganic phosphorus; *23DPG*, 2,3-diphosphoglycerate; *ATP*, adenosine triphosphate; *F16*, fructose-1,6-diphosphate; *ADP*, adenosine diphosphate

In this way, relative specific activities of the following compounds can be plotted against time: adenosine triphosphate, adenosine diphosphate, fructose-1,6-diphosphate, 2,3-diphosphoglycerate, and inorganic phosphate. With normal cells the curves shown in Fig. 1 are given.

It is obvious that a pool of glycolysis exists in the stroma separate from that in the intracellular fraction, since their activities do not show a parallel change. Also, in the intracellular fraction, 2,3-diphosphoglycerate shows a precursor relationship with adenosine triphosphate. This relationship is opposite to the findings of Gourley[4], who used methods involving partial hydrolysis of cell extracts to characterize each intermediate compound. Our findings would necessitate the operation of Rapoport's mutase[5] and the coenzyme action of 2,3-diphosphoglycerate in the conversion of 3-phosphoglycerate to 2-phosphoglycerate[6]. Since the phosphorus atom attached to the first carbon atom of 1,3-diphosphoglycerate is transferred to adenosine diphosphate by the 1,3-diphosphoglycerate phosphokinase[7], it is reasonable that 2,3-diphosphoglycerate, which is in equilibrium with the latter, should show a precursor relationship to adenosine triphosphate. These relationships will be discussed more fully at a later date when further observations will be reported.

This technique provides a simple method for studying simultaneously the effects of various substrates on the phosphate compounds of the red cell. For example, adenosine, known to be utilized by red cell hæmolysates[8], can be shown to be differentially metabolized by the stroma and intracellular fractions of normal and certain pathological cells[9].

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Highly Purified Choline Acetylase

The enzymatic synthesis of acetylcholine in the mammalian organism is inextricably linked with the general metabolism, especially with the general acetylating reactions. Hence it may be more rational to restrict the term 'choline acetylase' in its application to an enzyme which catalyses the reaction between choline and 'active acetate' or acetyl-coenzyme *A*, as shown in the following equation:

$$\text{Acetyl-Co}A + \text{choline} = \text{acetylcholine} + \text{Co}A.$$

According to Balfour and Hebb[1], there are two routes for biological synthesis of acetylcholine in mammalian tissues, namely, the acetate- and the citrate-utilizing system respectively.

Quite independently of Balfour's studies, we have already reported[2] a similar observation on a system synthesizing acetylcholine, in which emphasis was laid on the difference in the distribution as well as localization of both systems in mammalian tissues. Characteristically enough, the citrate system was found to be present abundantly only in nervous tissues, in contrast with the overall distribution of the acetate system in all tissues yielding acetylcholine. The universality of the acetate system was also demonstrated by the following observations. All the water-soluble extracts of such tissues as those listed in Table 1, which *per se* could scarcely synthesize acetylcholine, were shown to contain an accelerating factor enhancing the enzymatic synthesis of acetylcholine by guinea pig brain extract with acetate. In acetylcholine synthesis with citrate, on the other hand, we could not find any significant amount of such an accelerating factor.

The accelerating factor effective in the acetate system may be identical with the acetate-activating system or adenosine triphosphate–acetate reaction system described by Lipmann[3]. To verify this assumption, we had to separate choline acetylase from the acetate-activating system; this was accomplished by the following procedure, carried out at 4° C. or lower:

Table 1. Accelerating Effect of Some Tissue Extracts on the Synthesis of Acetylcholine

Tissue	No. of Exp.	Substrate: Acetate	Substrate: Citrate
Dog ventricular muscle	11	166 ± 6 per cent	109 ± 3 per cent
Guinea pig kidney	5	188 ± 11 „ „	111 ± 3 „ „
Guinea pig ventricular muscle	2	158 ± 8 „ „	108 ± 1 „ „
Guinea pig liver	2	128 ± 8 „ „	111 ± 6 „ „
Guinea pig skeletal muscle	1	136 „ „	112 „ „
Escherichia coli	1*	180 „ „	—
Control		100	100

Control mixture contained 3 μM adenosine triphosphate, 1·0 unit (for acetate system) or 0·3 unit (for citrate system) coenzyme *A*, 4 μM choline, 140 μM (for acetate system) or none (for citrate system) potassium chloride, 3 μM (for acetate system) or 5 μM (for citrate system) magnesium chloride, 15 μM cysteine, 1 μM eserine, 5 μM sodium fluoride, 3 μM phosphate, 10 μM acetate or citrate and dialysed water-soluble extract derived from 10 mgm. of freeze-dried powder of guinea pig brain. In testing mixture, fractionated extract of tissue listed above (20–40 gm./dl. fraction by ammonium sulphate) was added (* extract itself was used). *p*H 6·8. Final volume 1 ml. Incubated for 60 min. at 37° C. Figures indicate the amount of synthesized acetylcholine in testing mixture, expressed as a percentage of the control sample.

Preparation of Choline Acetylase

1 gm. freeze-dried powder of brain + 10 ml. *M*/50 phosphate (*p*H 6·8)
↓
Residue discarded ← Centrifuged for 20 min. at 1,500 *g*.
↓
Residue discarded ← Supernatant acidified with acetic acid to *p*H 4·5 and chilled for 5 hr. or more at 0° C.
↓
Clear supernatant (see text) neutralized to *p*H 6·8.
↓
Residue discarded ← Ammonium sulphate added to final concentration of 15 gm./dl.
↓
Supernatant discarded ← Ammonium sulphate added to final concentration of 35 gm./dl.
↓
Residue made up to 1 ml. with *M*/50 phosphate (*p*H 6·8) and dialysed against *M*/50 phosphate (*p*H 6·8)
↓
Residue discarded ← Acidified with acetic acid to *p*H 5·0 and chilled for 30 min. at 0° C.
↓
Supernatant neutralized to *p*H 6·8.

The choline acetylase thus prepared had lost almost completely its power to yield acetylcholine. However, when extract of kidney or *Escherichia coli* and other organisms were added, it regained its power to synthesize acetylcholine (Table 2). This implies that we have succeeded in separating choline acetylase almost completely from the acetate-activating enzyme system without losing its activity.

Further evidence was given by the following experiments (Table 3). Choline and 'active' acetate or acetyl-coenzyme *A*, prepared by the method of Littlefield and Sanadi[4], yielded acetylcholine under the influence of our choline acetylase without further addition of coenzyme *A*, adenosine triphosphate and acetate.

Our method of separating choline acetylase is also applicable to fresh brain tissues; but freeze-dried powder of guinea pig brain always gives the most satisfactory results. Under the most appropriate conditions, 1 mgm. of our choline acetylase was

Table 2. Synthesis of Acetylcholine by Coupling Choline Acetylase with the Acetate-activating Enzyme System

Example	Preparation	Acetylcholine synthesized (μgm./ml. hr.)
1	Complete system Choline acetylase (20 mgm./ml.) Kidney extracts* (15 mgm./ml.)	7·5 < 0·05 < 0·05
2	Complete system Choline acetylase (20 mgm./ml.) Kidney extracts* (15 mgm./ml.)	12·5 0·07 < 0·05
3	Complete system Choline acetylase (20 mgm./ml.) *Escherichia coli* extracts (40 mgm./ml.)	9·5 < 0·05 < 0·05

Details as in Table 1, except enzyme source. Figures in parentheses indicate the amount of freeze-dried tissue powder used.
* 20–40 gm./dl. fraction of ammonium sulphate was used.

Table 3. Synthesis of Acetylcholine from Choline and Acetyl-Coenzyme *A* by Choline Acetylase

	Acetyl-coenzyme *A* yielded by	Acetylcholine synthesized (μgm./ml.)
1	Guinea pig kidney (75 mgm.)	4·25
2	*Escherichia coli* (45 mgm.)	2·20

Each sample contained 4 μM choline, 8 μM cysteine, 3 μM phosphate and acetyl-coenzyme *A*. Extract of freeze-dried powder of kidney or *Escherichia coli* was incubated with adenosine triphosphate, coenzyme *A*, potassium and magnesium ions, cysteine and acetate at 37° C. After 90 min. incubation, the mixture was acidified to *p*H 3·5 and heated at 80° C. for 2 min. From this mixture active acetate or acetyl-coenzyme *A* was prepared by the method of Littlefield *et al.* (ref. 4). Figures in parentheses indicate the weight of the freeze-dried tissue used.

shown to synthesize 0·5 mgm. of acetylcholine an hour when coupled with the acetate-activating enzyme system.

In the course of preparing choline acetylase, it is worth noticing that the supernatant still contained a considerable amount of the citrate-activating system, after the first acidification in the preparation of choline acetylase, though the acetate-activating system had already been excluded almost completely.

Further purification of choline acetylase is now in progress; details of the present experiment will be published elsewhere.

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Evidence for the Occurrence of Glucose Dehydrogenase in Yeast

When buffered suspensions of washed bakers' yeast are incubated anaerobically with methylene blue, dehydrogenase activity as measured by the rate of decolorization is greater with glucose than it is with other substrates. While investigating the action of nicotine on various dehydrogenase systems, including those of yeast, we found that, whereas nicotine inhibited dehydrogenase activity of *Saccharomyces cerevisiae* with glucose, activation resulted with glucose-6-phosphate as substrate.

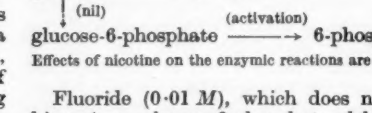
For these experiments we used cells harvested from young—not more than one day old—actively growing cultures. Before preparing the final suspensions in phosphate buffer, they were washed and aerated in suspension for two hours at 37° to reduce the dehydrogenase activity due to endogenous metabolites. Dehydrogenase activities in the presence of added substrate and triphenyltetrazolium bromide were measured at 30° and *p*H 7·5 by the method of Fahmy and Walsh[1].

For experiments using glucose-6-phosphate as substrate the cell membranes were first ruptured by alternately freezing and thawing, as the substrate was otherwise unable to penetrate the cells. Experiments showed that this procedure, though reducing dehydrogenase activity with glucose, did not influence the effect of nicotine; thereby demonstrating that the inhibitory action of nicotine was not due to its preventing the substrate from entering the cell.

Inhibitions up to 20 per cent by nicotine (0·01 *M*) were recorded with glucose. Activations up to 40 per cent by nicotine (0·01 *M*) were recorded with glucose-6-phosphate.

In view of these results, it became of interest to investigate the effect of nicotine on the hexokinase reaction. Partially purified hexokinase[2,3] was prepared from yeast. Activities were measured at 30° in bicarbonate buffer, *p*H 7·5, by the method of Colowick and Kalckar[3] using the Warburg apparatus. Nicotine (0·01 *M*) had no effect on the transfer of phosphate from adenosine triphosphate to glucose.

The significance of these findings is best appreciated by reference to the diagram.



Effects of nicotine on the enzymic reactions are indicated in brackets.

Fluoride (0·01 *M*), which does not inhibit hexokinase[4] or glucose-6-phosphate dehydrogenase[5], inhibits glucose dehydrogenase activity of yeast by 30–40 per cent.

So far as we are aware, glucose dehydrogenase has not hitherto been reported as occurring in yeast.

In its behaviour towards nicotine, we find that the glucose dehydrogenase activity of yeast resembles that of the enzyme[6] in mammalian liver. Liver glucose dehydrogenase was prepared and purified by the method of Brunelli and Wainio[7]. Its activity was measured by determining the oxygen uptake of a system containing, in addition to the enzyme, glucose, codehydrogenase I, Straub's heart flavoprotein[8] and methylene blue. Nicotine (0·01 *M*) inhibited by 15–18 per cent.

Glucose dehydrogenase activity, similarly inhibited by nicotine, occurs also in *Torulopsis utilis*.

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Oxidation of Glutathione in Extracts of Lens in the Presence of Ethylenediaminetetraacetate

CHELATING agents are being increasingly used for removing traces of metals. We therefore think it worth while to report a case where a chelating agent accelerated the oxidation of a substance which it was intended to preserve in the reduced state.

We extracted cattle lens with a neutral solution of ethylenediaminetetraacetate (EDTA, versene, sequestrine) to give a final concentration of 0·0067 *M* ethylenediaminetetraacetate with the object of removing traces of metals and thereby keeping the glutathione present in the extract fully reduced. We found that ethylenediaminetetraacetate promoted the oxidation of glutathione, which was stable in its absence for at least five days at 4° C. (Exp. 1, 2). The oxidation in ethylenediaminetetraacetate extracts was much slower in nitrogen (Exp. 3). Glutathione was not oxidized in the presence of 0·0013 *M* ethylenediaminetetraacetate unless the lens extract was also diluted (to 1 in 15) (Exp. 4, 5). There was no change in protein sulphydryl measured by titration with *o*-iodosobenzoate.

of ascorbic acid in lens extract remained almost unchanged for two days in the presence of ethylenediaminetetraacetate while glutathione was oxidized, but ascorbic acid was decreased on the fifth day when there was little glutathione left in the solution. Ascorbic acid is stable for at least five days (Exp. 2) in the absence of ethylenediaminetetraacetate. Further evidence pointing to ascorbic acid as the substance which directly causes glutathione oxidation is the fact that if ascorbic acid is removed from a water extract of lens by dialysis, and ethylenediaminetetraacetate and glutathione are then added to it, the glutathione is stable (Exp. 6); but if ascorbic acid is also added, oxidized glutathione is formed (Exp. 7). This takes place in either a water or in an ethylenediaminetetraacetate extract of lens (Exp. 8).

It is quite difficult to remove oxidized glutathione completely from lens proteins. It dialyses rather slowly out of lens extracts (Exp. 9), and repeated precipitation of lens protein with 50 per cent ammonium sulphate takes down relatively more oxidized glutathione than reduced glutathione (Exp. 10). We thought at first that the loss of glutathione in extracts of lens made in ethylenediaminetetra-

Exp. No.	Lens extract made with	Days at 4° C.	Mgm./100 gm. fresh lens			
			Glutathione	Oxidized glutathione	Glutathione + oxidized glutathione	Ascorbic acid
1	0·0067 *M* ethylenediaminetetraacetic acid	0	266	2	268	43·4
		2	142	103	245	38·4
		5	42	162	204	21·6
2	Water	0	224	—	—	55·0
		2	240	—	—	52·3
		5	240	—	—	51·2
3	0·0067 *M* ethylenediaminetetraacetic acid	0	222	—	—	—
	in air	2	151	—	—	—
	in nitrogen	2	205	—	—	—
4	0·0013 *M* ethylenediaminetetraacetic acid	0	256	0	256	
		2	246	0	246	
5	0·0013 *M* ethylenediaminetetraacetic acid (1 : 15 lens extract)	0	273	0	273	
		2	201	34	235	
6	Water. Dialysed 2 days then ethylenediaminetetraacetic acid to 0·0067 *M* and glutathione added	0	140	19	159	
		5	131	18	149	
7	Water. Dialysed 2 days then ethylenediaminetetraacetic acid to 0·0067 *M* and glutathione and 33 mgm. ascorbate/100 gm. lens added	0	222	0	222	
		2	184	34	218	
8	0·0067 *M* ethylenediaminetetraacetic acid. Dialysed 2 days against distilled water then ethylenediaminetetraacetic acid to 0·0067 *M* and glutathione and 47 mgm. ascorbate/100 gm. lens added	0	202	2	204	
		2	150	57	207	
		4	117	84	201	
9	0·0067 *M* ethylenediaminetetraacetic acid 2 days at 4° C.	2	90	74	164	
	Followed by 2 days dialysis against distilled water	2	0	13	13	
10	0·0067 *M* ethylenediaminetetraacetic acid 2 days at 4° C.	2	90	74	164	
	Protein twice precipitated with ammonium sulphate and redissolved		8	20	28	
11	0·067 *M* ethylenediaminetetraacetate acid					
	Unboiled	0	334	—	—	
	Boiled 3 min. pH 6	0	341	—	—	
	Unboiled	4	146	—	—	
	Boiled 3 min. pH 6	4	316	—	—	

Glutathione was estimated by the nitroprusside reaction[3] or by glyoxalase[4]; oxidized glutathione was estimated after electrolytic reduction to glutathione[5]. Ascorbic acid was estimated by titration with 2 : 6 dichlorophenolindophenol after precipitation of protein with metaphosphoric acid. Lens extracts were prepared from the lenses of freshly killed cattle by grinding with sand, extracting with twice their weight of fluid and centrifuging at 7,000 *g* for 5–10 min.

A solution of glutathione in 0·0067 *M* ethylenediaminetetraacetate is more stable than a solution in water, which suggests that oxidation of glutathione in ethylenediaminetetraacetate extracts of lens is secondary to some other reaction, such as the oxidation of ascorbic acid. This is known to be catalysed by ethylenediaminetetraacetate in the presence of metal ions and oxygen[1]. A lens extract normally contains both ascorbic acid and glutathione, and it is therefore possible that when ethylenediaminetetraacetate is added to such an extract it catalyses the oxidation of ascorbic acid, which is then non-enzymically reduced by glutathione which itself becomes oxidized. Experiment 1 shows that the level

acetate might indicate formation of a protein–glutathione compound similar to the compound of glutathione and glyceraldehydephosphate dehydrogenase described by Krimsky and Racker[2]. Glutathione could be liberated from this compound by boiling, and we have found that boiling will regenerate glutathione in lens extracts (Exp. 11). But it is known that if oxidized glutathione is heated with proteins it becomes reduced through reaction with protein-sulphydryl groups, and it is clearly this reaction that takes place when stored ethylenediaminetetraacetate extracts of lens are boiled.

It is possible that ethylenediaminetetraacetate will have a similar effect in extracts of tissues other

than lens and so destroy the substances its presence is intended to preserve.

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Lipid Nomenclature

Considerable confusion exists in the naming of compounds of the class now most commonly referred to as 'lipids'. It is indeed not yet agreed that the latter shall be the generic name, and the terms lipins, lipines, lipides and lipoids are in current use, together with derivative forms, galactolipins, etc., used to designate the complex members of the class. A profusion of empirical nomenclature has developed, particularly in the complex lipid field, often referring to compounds of dubious existence, and terms are frequently applied without distinction both to a single compound and to a crude 'fraction' containing this compound or possessing similar solubility properties. Several authors have directed attention to this state of affairs[1,2], and have made proposals for rectifying some of the anomalies.

Folch-Pi and Sperry[1] have suggested the replacement of the older system of classification, in which the phosphorus-containing lipids or phosphatides were divided into the monoaminophosphatides (lecithin and kephalin) and diaminophosphatides (sphingomyelins), by a division into phosphoglycerides, phosphosphingosides and phosphoinositides. The former use of the term 'phosphatide' to cover all the phosphorus-containing lipids is rejected in favour of a system in which the diacylglycerophosphoryl radical is termed 'phosphatidyl', 'lecithin' becoming 'phosphatidyl choline' and the 'kephalins' 'phosphatidyl serine', 'phosphatidyl ethanolamine', etc. This classification is very convenient and has won ready acceptance by many workers. The diacylglycerophosphates are already referred to as 'phosphatidic acids', which is in conformity with the proposed usage, although the former term seems preferable as being definitive and is not too cumbersome. 'Phosphoglycerides' is not very satisfactory as a name for the group, suggesting the 'phosphatidic acids' rather than their esters with hydroxyamino compounds. It is therefore suggested that it is replaced by 'phosphoglyceratids'. In view of the recent synthesis[2] of lipids in which glycol replaces glycerol in a lecithin type of structure, 'phosphoglycolatids' or 'phospholatids' is suggested as a suitable term, 'phospholatidyl choline', for example, designating an acylglycolphosphorylcholine. The retention of 'ol' in the latter term involves a minor inconsistency with the phosphoglyceratids, in which the 'ol' of glycerol is omitted. However, the alternative, 'phosphoglycatids', might involve confusion with sugar derivatives.

The term 'phosphosphingoside' proposed to replace sphingomyelin is very misleading, since the '-oside' termination suggests a glycoside and would lead to confusion with the sphingoglycosides (*q.v.*). An alternative term which would indicate the connexion with the phosphoglyceratids would be 'phosphosphingatids', although objection could be justifiably raised that no O-acyl group is present. It might therefore be more desirable to use a term such as 'phosphosphingamides', leading to 'phosphosphingamidyl choline' for the sphingomyelins already known, or, for a given individual, 'N-lignoceryl-phosphosphingamidyl choline' and allowing scope for extension as compounds of this structure, but involving other bases, are discovered or synthesized. However, the objection raised to 'phosphoglyceride' would apply to this term, and 'phosphosphingamatide' might overcome this point.

Older terms	Alternative proposals in the literature	Present proposals
Lipid, lipide, lipin, lipine and derivatives	—	Lipid and derivatives, for example, phospholipid, galactolipid, etc.
Monoamino-phosphatides	*Phospho-glycerides*	*Phosphoglyceratids*
Lecithin, kephalin	Phosphatidyl choline Phosphatidyl ethanolamine, etc.	Phosphoglyceratidyl choline *or* phosphatidyl choline Phosphoglyceratidyl ethanolamine, etc.
—	Glycollecithins (ref. 3)	Phosphoglycolatids *or* phospholatids Phosphoglycolatidyl choline *or* phospholatidyl choline, etc.
Diamino-phosphatides	Phospho-sphingosides	Phosphosphingamides *or* phosphosphingamatides
Sphingomyelins	Sphingolipides (ref. 4)	Phosphingamidyl choline *or* phosphosphingamatidyl choline, etc. Sphingolipids
Cerebrosides	Glycosphingosides	Sphingoglycosides
Ceramides	Sphingoglycosides	Sphingamides

Lignocerylsphingosine and similar sphingosine amides at present styled 'ceramides' might be more suitably named 'sphingamides'.

Since the structures of the compounds termed 'phosphoinositides' by Folch-Pi and Sperry have not been established with any certainty, any attempt to include these in an analogous terminology would be premature.

Carter and Celmer (*loc. cit.*) prefer the term 'sphingoglycosides' to 'glycosphingosides', which was proposed by Folch-Pi and Sperry to replace 'cerebrosides'; and since, as the former authors point out, the compounds are glycosides, the point seems well taken.

It would seem to be extremely desirable for the appropriate International Union to go into the whole question of lipid nomenclature, in order that a generally acceptable terminology might be adopted.

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Sex Ratio in Spawning Populations of *Lampetra planeri*

The question of the sex ratio in lampreys is of some interest in view of the occurrence of hermaphrodite gonads in the ammocoete larva; but there are wide divergencies in the figures given by previous workers in Europe and North America.

My own observations on *L. planeri* show that the ratio varies in different streams and even from year

Table 1

Year	Total seen or captured	No. of visits	No./visit	Males	Females	Ratio: male/females
1947	83	3	28	60	23	2·6
1949	64	5	13	35	29	1·2
1950	126	6	21	90	36	2·5
1951	182*	8	23	100	46	2·2
1952	113*	7	16	56	32	1·8
1953	197*	9	22	143	54	2·6

* Total includes animals not sexed.

to year, and suggest that such variations may be responsible for these conflicting reports.

Table 1 records the results of systematic observations on the River Yeo (north Somerset) over a period of six years and, except for 1947, these observations were maintained from the first appearance of the adults in late March or early April to their final disappearance at the end of April. Visits were spaced at intervals of three or four days, and on each occasion a complete search was made of the restricted stretch of the stream where the animals occur. As an objective index of relative frequency the number of animals seen or captured per visit is to be preferred to the total number, as the latter takes no account of the varying durations of the spawning season and differences in the number of visits made from one year to another.

The total figures for the six years give a ratio of 2·2, and on only one day in the whole period has the number of females exceeded the males, while for more than half the observation days the males have exceeded the females by more than 2 : 1.

The records do not bear out the findings of Zanandrea[1] that the excess of males increases as the season advances, or his suggestion that this is due to the greater survival-rate of the male. In 1951, when spawning reached its peak later than in any other year, the ratio was 2·2; yet in 1950, when it occurred some three weeks earlier, the proportion of males was even larger (2·5). Moreover, if the numbers are grouped as weekly totals the smallest proportion of males is to be found in the last week of the spawning season.

The annual variations in sex ratio are interesting when compared with the estimates of relative total numbers. Thus, in the years 1949 and 1952 when the total population was smallest the sex ratio was only 1·2 and 1·8 as against 2·6, 2·5 and 2·2 in the years when the total population was greater. Excluding 1947, when only three visits were made, the number of females in any one year varied only from 29 to 54 as against 35 to 143 for the males. Variations in total numbers have therefore been due in large part to variations in the number of males.

Collections from a small area in south-east Somerset in 1938 and 1939 consisted of 139 males and 129 females, and in each year the sexes were present in nearly equal numbers[2]. These local and annual differences in the sex ratio suggest that the orientation of sex in the ammocoete is influenced by environmental conditions such as temperature and nutrition.

Note added in proof. The results recently obtained for 1954 are consistent with those of previous years in showing a low ratio of males to females (1·6) with a relatively small total population (total 126 and number observed per visit 16).

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[1] Zanandrea, G., *Boll. Pesc. Pisc. Idrobiol.*, **6** (1951).
[2] Hardisty, M. W., *J. Animal Ecol.*, **13**, 2 (1944).

A Violet Pigment from the Mediterranean Medusa *Rhizostoma pulmo*

In the subtentacles and marginal bodies of the Mediterranean medusa *Rhizostoma pulmo* a violet pigment occurs which can be extracted by means of distilled water at 2°–4°. By filtering and evaporating to dryness the deep violet-coloured solution in vacuum, and redissolving it three or four times, we finally obtained an amorphous violet residue, insoluble in common organic solvents, but giving with antimony trichloride in chloroform a blue carotenoid-like reaction. The violet colour is constant between *p*H 1·4–10·0. Over and below this *p*H it becomes pink. Addition of hydrogen peroxide decolorizes the solution. The violet solution shows a bluish fluorescence in ultra-violet light, and a characteristic absorption spectrum with three peaks at 6150 A., 5750 A. and 5250 A. (Fig. 1).

On heating the pigment solution over 50° it becomes brownish-yellow with precipitation of denaturated protein and simultaneous disappearance of the absorption bands.

The pigment is probably a conjugated protein with a prosthetic group belonging, or related, to the carotenoids. This conclusion is adopted because of the similarity of the reaction with antimony trichloride, and the decolorization with hydrogen peroxide, as also to the resemblance of the spectrum.

Further researches are in progress.

Investigations concerning the composition of the mesogloea from *Rhizostoma pulmo* have produced evidence that its protein is very poor in total nitrogen (20–26 mgm. per cent nitrogen) and is partially conjugated with silicon.

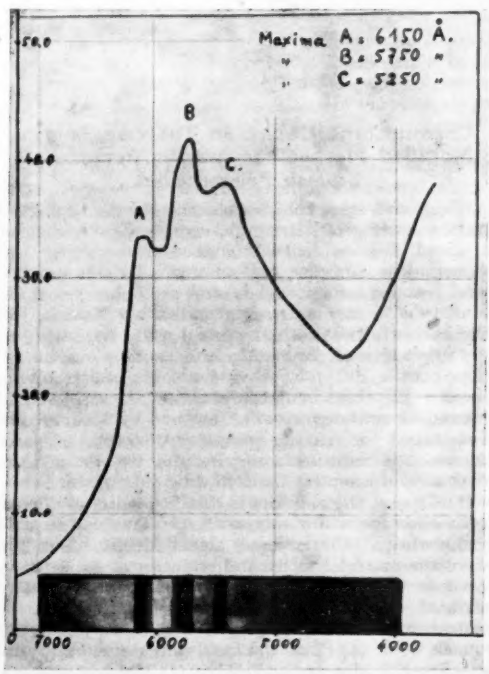

Fig. 1

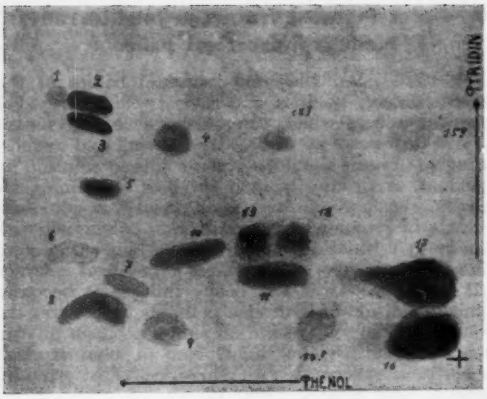

Fig. 2. 1, Phenylalanine; 2, *iso*leucine; 3, leucine; 4, tyrosine; 5, valine; 6, proline; 7, methionine; 8, arginine; 9, lysine?; 10, alanine; 11, glycine; 12, serine; 13, threonine?; 14, unidentified; 15, ammonium salts; 16, aspartic acid; 17, glutamic acid; 18, glucosamine

Chromatograms show that the jelly tissue yields, after hydrolysis, in addition to glutamic acid, leucine, *iso*leucine, valine, aspartic acid, arginine, perhaps lysine, proline, methionine, alanine, glycine, serine, an amino-acid travelling with threonine, and at least two unidentified amino-acids of which one (No. 18) could be (it is not yet definitely proved) glucosamine (Fig. 2).

Fuller details of this work will be published in the *Bulletin of the Academy of Sciences, Athens*.

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Chromosome Counts in Tunicates and a Modified Method for making Permanent Squash Preparations

When collecting tunicates at the Marine Biological Station at Roscoff (Brittany) we wondered whether it would be possible to introduce the cytogenetical element into tunicate systematics. To this end we tried acetocarmine squashes after preliminary soaking in distilled water as recommended by Makino and Nishimura[1]. The method worked well; but owing to the small size of cells and chromosomes our microscope outfit did not provide a sufficient resolving power. We then made permanent preparations for examination at home. The method of Makino and Nishimura[1] for making permanent squash preparations not giving satisfactory results, we modified the method and adopted the following procedure.

(1) Dissect the material in distilled water and leave it to soak for a few minutes. (2) Transfer to cold acetocarmine (40 per cent glacial acetic acid) and leave the material to fix and stain for at least thirty minutes, but in general no longer than forty-five minutes. Should the material be left too long in the acetocarmine or should it be heated in it, it will not squash well. (3) Place the fixed and stained material on a heavily albuminized slide. (4) Moisten one side of a piece of 'Cellophane' with albumin and place the

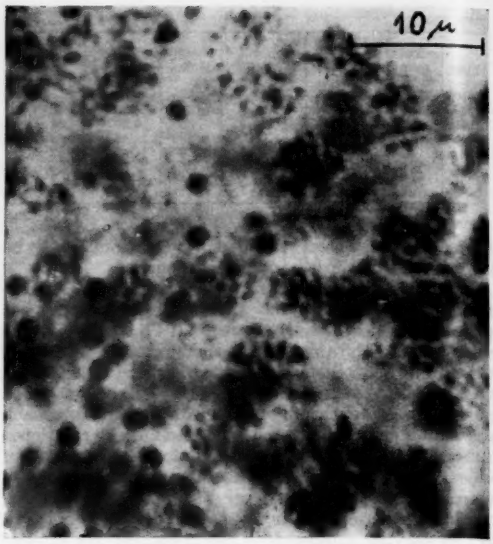

Fig. 1. Meioses in *Aplidium proliferum*

'Cellophane' on the material, the moistened side downwards. Flatten out creases and remove air bubbles. (5) The material under the 'Cellophane' is now rolled out by means of a glass rod or squashed by application of pressure with a cover-slip. (6) Heat the slide gently by passing it over a small flame a few times, then place it quickly in a dish with distilled water. The heating should be just sufficient to allow for the coagulation of the albumin close to the slide. If the heating was insufficient the material will come off together with the 'Cellophane' in the distilled water. If the heating was too great the 'Cellophane' will not come away and the material may be damaged. The correct amount of heating, which

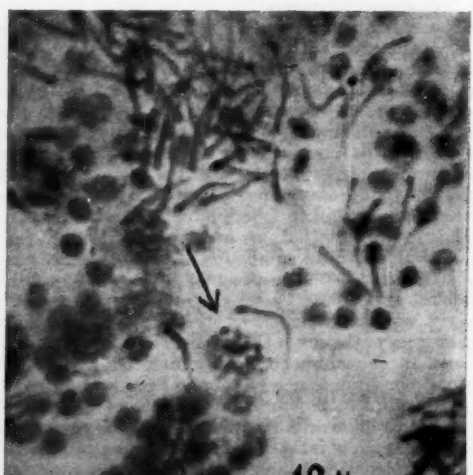

Fig. 2. Meiosis in *Sidnyum elegans*

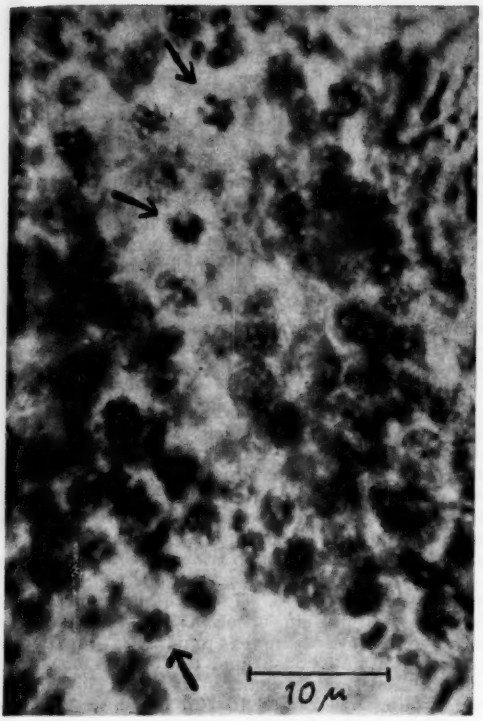

Fig. 3. Meioses in *Pyura microcosmus*

can only be learned by personal experience, ensures that the 'Cellophane' floats off, while the squashed material adheres to the slide. (7) Dehydrate and mount in the ordinary manner.

Employing this procedure, we made permanent acetocarmine squash preparations of whole abdomens of *Aplidium proliferum* (Milne Edwards), *Sidnyum elegans* (Giard) and *Sidnyum turbinatum* (Savigny) and of pieces of gonads of *Pyura microcosmus* (Savigny). These were examined in Amsterdam with the aid of a fluorite oil-immersion objective.

We found suitable stages of meiosis in preparations of *Aplidium proliferum* (Fig. 1), *Sidnyum elegans* (Fig. 2) and *Pyura microcosmus* (Fig. 3). Our count for *Aplidium proliferum* was $n = 14$, for *Sidnyum elegans* $n = 9$ and for *Pyura microcosmus* $n = 8$.

So far as is known to us this is the first instance in which chromosomes have been observed in tunicates. Although the tunicates are far from ideal for cytogenetical work, on account of the small size of the chromosomes, such cytogenetical work does not seem impossible.

Our modified method for making permanent squash preparations has also been tried with fair results on botanical material (anthers). Botanical material may require a different staining procedure.

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Distribution and Chromosome Number of *Allium paradoxum* in Gloucestershire

There is only one record of *Allium paradoxum* (M. Bieb.) G. Don. in the "Flora of Gloucestershire" (p. 465; 1948). During a study of the ecology of this population at Bartonbury, other centres have been located near Chesterton and on the Bath Road. The chromosome number of the species has been investigated in Feulgen squashes[1] of root tips treated with mono-bromo naphthalene[2], and in aceto-carmine[1] and Feulgen squashes[1] of anthers. The chromosome number found in the Bartonbury populations is $2n = 16$. Pollen grain mitosis has been observed in detail and records are as follows:

Plants	Pollen grains at metaphase	Haploid chromosome number	
		8	7
15	107	106	1

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[1] Darlington, C. D., and LaCour, L. F., "Handling of Chromosomes" (Allen and Unwin, 1947).
[2] O'Mara, J. C., *Stain Tech.*, **23**, 201 (1948).

Hatchability of Hen Eggs and Lymphomatosis

It is widely accepted that poor hatchability is one of the main causes of financial loss to poultry breeders. Judging from the results regularly reported by many large hatcheries, the national hatching-rate of all eggs set in Great Britain seems to be between 65 and 70 per cent.

The failure of an egg to hatch may be due—apart from defects in the incubator—to infertility or to some factor, often a nutritional deficiency, which causes the developing embryos to die at varying stages during the full term of twenty-one days. Fertility is now accepted as a heritable factor[1] and has no obvious relationship with embryonic mortality, although by many poultry breeders the two conditions are regarded under the one heading of 'hatchability'. There are some grounds for this in that attention to one factor, for example, fertility, usually leads to greater attention to the other and, as a consequence, improved fertility is often accompanied by lower embryonic mortality. Moreover, it is impossible merely by candling to distinguish between infertile eggs and fertile eggs in which very early embryonic death has supervened.

Lymphomatosis is a further cause of reduced profits in the poultry industry, and in its several manifestations is probably responsible for approximately 25 per cent of the adult mortality among domesticated fowl in Britain[2]. In endeavouring to breed lines resistant to this disease, it was observed that those dams which appeared most satisfactory on grounds of high egg numbers and high hatching-rate of all eggs set most frequently proved to be those having progeny among which the incidence of lymphomatosis was greatest. In consequence, these families were discarded. Inspection of the records over the several years revealed the fact that a remarkably close correlation between high hatchability and the incidence of lymphomatosis in the

Table 1. Hatching Results with Dams the Progeny of which had no Lymphomatosis over First Eighteen Months of their Lives

	Eggs set	Infertile	Hatch of fertile eggs	Per cent
1950	897	149	639	85
1951	1,189	308	656	74
1952	1,243	152	809	74
1953	2,668	348	1,877	81

Hatching Results with Dams the Progeny of which Evinced Lymphomatosis over First Eighteen Months of their Lives

	Eggs set	Infertile	Hatch of fertile eggs	Per cent
1950	1,492	76	1,279	90
1951	2,809	361	1,968	80
1952	1,736	178	1,235	79
1953	985	110	758	86

progeny of dams evincing high hatchability was apparent each year since lymphomatosis became manifest in the flock (Table 1).

Inquiries among a small number of flock owners who keep complete records have indicated that a similar parallelism is found. Lymphomatosis is present in varying degrees of intensity in the flocks of most breeders in Britain although in many the incidence on the farm is extremely low. Pedigree breeders rarely have post-mortem examinations carried out on every bird dying, still less on birds culled as 'poor doers', although such birds may be affected by lymphomatosis. Nevertheless, many breeders are reluctant to breed from full sister groups where one bird or more has died or has had to be culled. It may therefore be that, if this policy no longer operated, the incidence of lymphomatosis—already high—might become higher, and progress towards improved hatching-rates among first-class pedigree breeders may be possible only when the full implications of lymphomatosis are more fully understood.

The relationship between the disease and hatching-rates is not obvious and further investigations are being pursued by us.

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[1] Blyth, J. S. S., *Proc. Roy. Soc. Edin.*, **62**, 191 (1945).
[2] Coles, R., *Poultry Science* (in the press, 1954).

Relationship of Œstrogen and Progesterone in Œstrous Behaviour of the Ewe

It has been clearly demonstrated that for œstrus to accompany ovulation in the sheep the animal must have been under progesterone influence for several days[1–4].

In attempts to elucidate this phenomenon two series of experiments were conducted between June 1952 and December 1953 at the State Research Farm, Werribee. In the first series, twelve ovariectomized Suffolk cross-bred ewes were used in two groups, *A* and *B*, of six ewes each. Each group received the same level of œstradiol benzoate in oil, one group also receiving 75 mgm. progesterone, in six divided injections each of 12·5 mgm. for three days, commencing five days before œstrogen injection. Treatment was repeated at fourteen-day intervals for three treatments at each level of œstrogen, from 5 mgm. successively down to 8 μgm. by a factor of 0·2. At the end of each six-week period the groups were switched; that group which had received œstrogen alone for the three preceding treatments received progesterone before each of the succeeding three treatments, and vice versa. The level of 8 μgm. was below the threshold for response, so the level was raised to 20 μgm. for the three concluding treatments.

At no level of œstrogen injection was it possible to induce œstrus regularly in a high proportion of ewes treated. When progesterone preceded œstrogen, regular cycles of œstrous behaviour were readily induced by all levels of œstrogen down to 40 μgm. A level of 20 μgm. appeared marginal. Between the limits of 5 mgm. and 40 μgm. œstradiol benzoate, the number of ewes treated, the number and the percentage responding, of progesterone–œstrogen and œstrogen-treated animals were: 96, 86, 90 per cent and 72, 21, 29 per cent, respectively. Progesterone pretreatment advanced the time of onset of œstrus by 12–24 hr.

The second series of experiments consisted of seven assay-type trials, involving seventy-two ovariectomized cross-bred Suffolk ewes, conducted at 4-weekly intervals from June until December 1953. All ewes were primed midway between each trial with 50 μgm. œstradiol benzoate. Dose–response lines were obtained for progesterone–œstrogen and œstrogen alone. In the last two trials, direct comparisons were made, using criteria of œstrous behaviour and vaginal smear change. Progesterone pretreatment reduced the median effective dose of œstradiol benzoate, for œstrus from 64 μgm. to 22 μgm. (99 per cent fiducial limits 52–81 and 19–26), and for vaginal cornification from 24 μgm. to 14 μgm. (99 per cent fiducial limits 20–28 and 10–17). When progesterone preceded œstrogen, the nature of the reaction appeared changed: the dose–response line was steeper and the onset of œstrus earlier.

It is concluded, therefore, that œstrus in the ewe is under dual progesterone–œstrogen control and that this accounts for the phenomenon of 'silent œstrus', or ovulation without œstrus, which occurs at the first ovulation of the breeding season, or when ovulation is induced by gonadotrophin injection in anœstrus.

Full details of these experiments are being published elsewhere, where acknowledgment will be made to the various individuals and organizations who have given valuable aid in this research.

T. J. Robinson

School of Agriculture,
University of Melbourne,
Victoria, Australia.
Feb. 3.

[1] Dutt, R. H., *J. Animal Sci.*, **11**, Proc., 792 (1952).
[2] Dutt, R. H., *J. Animal Sci.*, **12**, 515 (1953).
[3] Robinson, T. J., *Nature*, **170**, 373 (1952).
[4] Robinson, T. J., *J. Endocrinol.*, **10**, 117 (1954).

Presence and Absence of the Pre-Natal Check in Lambs' Birthcoats

Fraser, with Hamada[1], has stated that non-*N*-type and *N*-type lambs differ in the presence of the pre-natal check in the former and its absence from the latter, and this view is adopted by Waddington[2].

Sickle-fibres constitute the most easily perceived evidence of the pre-natal check[3–5]. Of ten *N*/+ *N*-grade lambs studied in a number of body regions, all had sickle-fibres on the shoulder patch and shoulder,

and they were present on several necks, withers, sides and backs, but not on any britch. On eight of the shoulder patches fine sickle-fibres were present.

Sickle-fibres are less plentiful on *N*/*N* lambs. They have been recorded before on the side (D. A. Ross and F. W. Dry), but they have not been found on the back (Janet M. Ross and Wright). On only one of six *N*/*N* lambs examined recently on seven positions have sickle-fibres been found anywhere but on the shoulder patch, namely, chalky sickle-fibres on the neck and side, and fine sickle-fibres on the shoulder patch region. Seven of twelve additional *N*/*N* lambs had sickle-fibres on the shoulder patch region; none of these was fine sickles. Super-sickle-*B* fibres, which have part of the neck region fine and non-medullated, also reveal the presence of the pre-natal check. They have been found on several body regions of a number of homozygotes. Sickle-fibres are easy to find on recessive-*N*'s, but the details need not be given now.

Sickle-fibres have been found low on the leg of six weeks' old +/+, *N*/+ and *N*/*N* lambs. The covering looked like that of a short-coated wild sheep, but the hind-legs of Romneys can come later to be more or less woolly down to the hoofs.

In a specimen cut from the hip of a three weeks old Mouflon, kindly supplied by Mr. P. G. Schinckel, of Roseworthy Agricultural College, a pre-natal check is revealed by an array tentatively called saddle. Fibres with an apical end approaching the characteristic sickle form, but less sharply curved at the butt of the apical curve and becoming finer more gradually, have a finely crimped neck region and, doubtless following the birth point, become coarser basally. The pre-natal check is thus recognized in a wild sheep. By contrast, in a specimen from the pelt of a nine-day Barbary lamb, for which we are also indebted to Mr. Schinckel, there is nothing to interpret as evidence of a pre-natal check, although some of the short finest fibres, which are crimped, have an apical curve faintly suggestive of a sickle-end.

There is need for much more work and thought on the mechanism of the pre-natal check and its place in the evolution of the fleece.

F. W. Dry
S. K. Stephenson

Massey Agricultural College,
Palmerston North, N.Z.
Jan. 20.

[1] Fraser and Hamada, *Proc. Roy. Soc. Edin.*, B, **44**, 462 (1952).
[2] Waddington, Quinquennial Report 1947–1951 of the Institute of Animal Genetics, University of Edinburgh (1952).
[3] Dry, *J. Text. Inst.*, **24**, T161 (1933).
[4] Dry, *N.Z. J. Agric.*, **48**, 331 (1934).
[5] Dry, *N.Z. Sci. Rev.*, **5**, 69 (1952).

Delayed Implantation in the Harbour Seal, *Phoca vitulina* L.

Published observations on harbour seals generally have indicated the belief that mating in this species, at least in temperate zones, occurs in August and September, with a peak in September. The reasons for this apparently are twofold. First, the animals seem to be more gregarious at hauling-out sites in August and September than at other times of the year, and display more than the usual amount of quarrelsome and noisy activity then. This has been taken to indicate sexual activity, and seal hunters have reported apparent acts of copulation at this time. Secondly, small embryos taken in October and November are of such a size as to suggest that implantation took place in August or September. Scheffer and Slipp[1] give the curvilinear length of an embryo taken in Washington State between September 12 and 15 as 103 mm., and state that spermatogenesis begins early in July. Havinga[2] gives the length of the smallest embryo seen by him as 10 cm., taken in December, and states that mating in Dutch waters takes place in August and September. Imler and Sarber[3] state that while the mating season is unknown, embryos taken in Alaska from a fraction of an inch to about 1½ in. in length are found from mid-October to well into November. Fisher[4] reported that the testes of a large male harbour seal taken in British Columbia on September 25 were sexually active, and thought that mating occurred at this time of year.

During the past few years, harbour seals from Nova Scotia and New Brunswick have been examined at St. Andrews, N.B., as a part of general life-history studies of pinnipeds on the Canadian east coast. A series of forty-eight reproductive tracts of adult female harbour seals taken from May to October since 1950 has yielded interesting information on the reproductive cycle in this species. Whelping in Nova Scotia and New Brunswick waters occurs in May and June with a peak early in June. A study of the ovaries has revealed that the corpus luteum of pregnancy in gross appearance persists throughout lactation (two to three weeks) as a large body, which looks functional, although it displays from late pregnancy early microscopic signs of retrogression similar to those outlined by Harrison, Matthews and Roberts[5]. Grossly visible signs of retrogression, with large mature follicles generally in the opposite ovary, have been noted as early as June 13. By early July retrogression is advanced, and new corpora lutea have been found as early as July 3. From this date until September 19, a well-spread series of thirty specimens shows a large (although smaller than maximum size attained) new fully filled-in corpus luteum in each set of ovaries, no mature follicles, and no evidence of implantation or embryonic development. Two reproductive tracts taken on September 20 and 21 each contained a typical implantation site in one cornuum of the uterus, consisting of a small bulbous swelling about the size of a marble. One specimen on October 3, two on October 7, and one on October 11 contained embryos 4 mm., 9 mm., 15 mm. and 17 mm. long respectively. A series of embryos taken from this date until March shows progressive development from these sizes. No sexually mature females without embryos have been taken after September 20.

It appears, therefore, that harbour seals in the waters of Nova Scotia and New Brunswick, and probably elsewhere in similar latitudes, mate immediately upon the termination of lactation late in June or early in July, and that implantation is delayed until September. No evidence of copulation at any time has been obtained, and it is felt that copulation must take place chiefly in the water. There are the usual noisy gatherings of seals in August and September at hauling-out sites, but these it seems cannot be attributed to sexual activity.

Evidence gathered and being gathered by other workers in this field[5,6] indicates that the phenomenon of delayed implantation is the rule in the family

Phocidae and probably in the eared seals as well. The results of work being carried out by other investigators on Arctic species should be available before long to help complete the picture.

A fuller treatment of the material mentioned here, together with the results of histological examination of a series of testes now in progress, will be presented in a later paper.

H. D. Fisher

Fisheries Research Board of Canada,
Atlantic Biological Station,
St. Andrews, N.B., Canada.
March 2.

[1] Scheffer, V. B., and Slipp, J. W., *Amer. Mid. Nat.*, **32**, (2) (1944).
[2] Havinga, B., *Tidjdschr. ned dierk. Ver. Leiden*, (31), 3 (1933).
[3] Imler, H., and Sarber, H. R., U.S. Fish. Wild. Service, Spec. Sci. Rep., No. 28 (1947).
[4] Fisher, H. D., Fish. Res. Bd. Can. Bull., No. 93 (1952).
[5] Harrison, R. J., Matthews, L. H., and Roberts, J. M., *Trans. Zool. Soc. Lond.*, **27**, Pt. 5 (1952).
[6] Gibbney, L., *Nature*, **172**, 4378 (1953).

Evolution and Epistemology

Prof. E. Schroedinger's recent book[1] discussing the relevance of ancient Greek thought to present-day scientific philosophy touches on very many of the problems which have been debated throughout the whole history of Western civilization. He closes it (p. 94) with the thought, adumbrated perhaps already by Democritus (see p. 30), that "for the purpose of constructing the picture of the external world, we have used the greatly simplifying device of cutting our own personality out, removing it . . . this is the reason why the scientific world-view contains of itself no ethical values, no aesthetic values, not a word about our own ultimate scope or destination, and no God, if you please".

But has not recent biological thought added to the picture a factor which Schroedinger fails to take into account? We believe now that the intellectual-sensory apparatus by which we make contact with the external world arose through a process of evolution. According to classical neo-Darwinian views, the process by which it came into being, and acquired the characteristics which it has in man, depended on the occurrence of random changes which were selecting according to their effectiveness in furthering the reproductive ability of the individual animals concerned. If this is true, it is no longer adequate to frame a discussion in terms of a dichotomy between "our personality" and an impersonal world which we arrive at by "cutting our personality out". The faculties by which we arrive at a world view have been selected so as to be, at least, efficient in dealing with other existents. They may, in Kantian terms, not give us direct contact with the thing-in-itself, but they have been moulded by things-in-themselves so as to be competent in coping with them.

I believe one can go further than this in asserting a congruity between our apparatus for acquiring knowledge and the nature of the things to be known. I have suggested[2] that evolution operates not so much by the differential reproduction of chance variations of phenotype, but by the selection of genotypes which endow their possessors with the capacity to react adaptively with their surroundings (adaptive being defined in terms of reproduction). From this point of view it is easier to envisage the possibility that our mental equipment is not merely one that happens to be reasonably efficient, but that it has been shaped precisely to fit the character of those things with which it has to make contact. If this were so, the fundamentals of "our personality" must still be implicit in the scientific world-view, and attempts to find them there (such as a tentative one of my own[3]) cannot be dismissed as impossible of fulfilment.

C. H. Waddington

Institute of Animal Genetics,
University of Edinburgh.
March 27.

[1] Schroedinger, E., "Nature and the Greeks" (Cambridge University Press, 1954).
[2] Waddington, C. H., *Nature*, **150**, 563 (1942); *Evolution*, **7**, 118, 386 (1953).
[3] Waddington, C. H., and others, *Nature*, **148**, 270 (1941); "Science and Ethics" (Allen and Unwin, 1942).

Forecasting Weather from Solar Radiation

I feel that the burden of Dr. C. E. P. Brooks's review of my recent paper (see *Nature*, Dec. 12, p. 1089) does me injustice.

I claim the discovery of a family of periodic variations, more than twenty in number, all to within 1 per cent, integral sub-multiples of $22\frac{3}{4}$ years. For meteorological applications it makes no difference how I was led to make this claim. The question is: Does this family of periods occur in meteorological records?

In my paper in Smith. Misc. Coll., Vol. 122, No. 4, 1953, a single illustration, Fig. 19, demonstrates five of these periods in the precipitation at Albany, N.Y., namely, $45\frac{1}{2}$, $22\frac{3}{4}$, $15\frac{1}{6}$, $11\frac{3}{8}$ and $9\frac{1}{10}$ months. The range of these periodic variations is from 7 to 25 per cent of normal precipitation at Albany. In another paper, Smith. Misc. Coll., Vol. 101, No. 1, 1941, I show that another of the periods, $\frac{1}{4}$ of $22\frac{3}{4}$ years, is associated with changes of temperature at Copenhagen, Vienna and New Haven, from 1800 to 1932, amounting to 1·2 deg., 1·1 deg. C., and 1·3 deg. F., respectively. Also in Smith. Misc. Coll., Vol. 111, No. 13, 1949, I claim two periods in New York and Washington temperature. I now see that, to within one part in 8,000, these are 1/1,250 and 1/2,500 of $22\frac{3}{4} \times 365\frac{1}{4}$ days.

By adding together in proper phases the effects of twenty-two periods on the precipitation at Albany, I make a prediction, thirty years in advance of its basis, for 41 months, 1928–31, which gives a correlation coefficient of 75 ± 7 per cent. I also add the effects of more than twenty periods, based on Washington temperature records of 1854–1939, which, according to Dr. Brooks, enables a prediction for 18 months of 1952 and 1953 to make a 2 to 1 score.

It seems to me that such results deserve fairer consideration than the saying: "But even granted that the solar constant does vary, the variations found by Dr. Abbot are so small—only one or two per cent—that their direct effect on surface temperatures would be barely perceptible". As stated above, the question, Does a family of periodicities, integrally related to $22\frac{3}{4}$ years, occur in weather?, is quite independent of the question, Does this family occur in solar variation?

C. G. Abbot

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Washington 25, D.C.

FORTHCOMING EVENTS

*(Meetings marked with an asterisk * are open to the public)*

Monday, May 10

ROYAL GEOGRAPHICAL SOCIETY (at 1 Kensington Gore, London, S.W.7), at 8.15 p.m.—Mr. W. F. Grimes: "Exploration of Roman and Medieval London".

Tuesday, May 11

ZOOLOGICAL SOCIETY OF LONDON (at the Zoological Gardens, Regent's Park, London, N.W.1), at 5 p.m.—Scientific Papers.

INSTITUTE OF METAL FINISHING, ORGANIC FINISHING GROUP (at the British Institute of Management, Management House, Hill Street, London, W.1), at 6.30 p.m.—Discussion on "Cellulose v. Synthetics".

UNIVERSITY OF LONDON (at the Institute of Archæology, Inner Circle, Regent's Park, London, N.W.1), at 8.15 p.m.—Dr. G. H. S. Bushnell: "Recent Work in Archæology outside Europe"—(1) "South America".*

Wednesday, May 12

ROYAL SOCIETY OF ARTS (at John Adam Street, Adelphi, London, W.C.2), at 2.30 p.m.—Mr. John N. Summerson: "The Society's House and Earlier Homes" (Peter Le Neve Foster Lecture).

GEOLOGICAL SOCIETY OF LONDON (at Burlington House, Piccadilly, London, W.1), at 5 p.m.—Dr. R. G. S. Hudson, Dr. M. Chatton and Mr. R. V. Browne: "The Geology of Jebel Qamar, Oman". Dr. D. H. Oswald: "The Carboniferous Rocks between the Ox Mountains and Donegal Bay" (this paper will be read by Prof. T. Neville George).

ROYAL STATISTICAL SOCIETY, RESEARCH SECTION (at the London School of Hygiene and Tropical Medicine, Keppel Street, London, W.C.1), at 5.15 p.m.—Symposium on "Interval Estimation".

NEWCOMEN SOCIETY (in the Lecture Theatre of the Science Museum, South Kensington, London, S.W.7), at 6 p.m.—Prof. Charles Singer: First Dickinson Biennial Memorial Lecture.

Thursday, May 13

ROYAL SOCIETY (at Burlington House, Piccadilly, London, W.1), at 4.30 p.m.—Sir Ian Heilbron, F.R.S.: "Brewing in Relation to Natural Science".

LONDON MATHEMATICAL SOCIETY (in the New Chemistry Block, University of Sheffield, Sheffield), at 5 p.m.—Prof. A. M. Macbeath: "The Concept of 'Mapping' in Undergraduate Mathematics".

PHYSICAL SOCIETY (in the Rooms of the Royal Astronomical Society, Burlington House, Piccadilly, London, W.1), at 5 p.m.—Prof. A. Kastler (France): "Les Méthodes Optiques d'Orientation Atomique et Leurs Applications" (Ninth Holweck Lecture).*

SOCIETY OF CHEMICAL INDUSTRY, FOOD GROUP (in the British Legion Room, Memorial Hall, Chorleywood, Herts), at 6.30 p.m.—Dr. J. B. M. Coppock: "Science and the Baker".

ROYAL AERONAUTICAL SOCIETY (at 4 Hamilton Place, London, W.1), at 7 p.m.—Mr. H. L. Cox: "The Use of Materials in the Plastic Range".

BRITISH PSYCHOLOGICAL SOCIETY (joint meeting with the BRITISH SOCIOLOGICAL ASSOCIATION, in the Tuke Hall, Bedford College, Regent's Park, London, N.W.1), at 8 p.m.—Prof. Otto Klineberg (Colombia University): "National Stereotypes: Scientific and Practical Implications".

Friday, May 14

ROYAL ASTRONOMICAL SOCIETY (at Burlington House, Piccadilly, London, W.1), at 4.30 p.m.—Scientific Papers.

UNIVERSITY COLLEGE LONDON (in the Anatomy Theatre, Gower Street, London, W.C.1), at 5.30 p.m.—Dr. M. Ray Denny (Michigan State College): "Learning Theory and Experimental Extinction".*

ROYAL INSTITUTION (at 21 Albemarle Street, London, W.1), at 9 p.m.—Sir Harold Spencer Jones, F.R.S.: "The Scale of the Universe".

Saturday, May 15

BIOCHEMICAL SOCIETY (in the Department of Physiology, The University, Bristol 8), at 11 a.m.—Scientific Papers.

APPOINTMENTS VACANT

APPLICATIONS are invited for the following appointments on or before the dates mentioned:

PRINCIPAL SCIENTIFIC OFFICER (with a first- or second-class honours degree in engineering, mathematics or physics, or equivalent qualifications) IN THE DEPARTMENT OF SCIENTIFIC AND INDUSTRIAL RESEARCH, Mechanical Engineering Research Laboratory, East Kilbride, near Glasgow, to lead a small team on work initially concerned mainly with the general field of stress analysis, both analytical and experimental, and later including vibration and photo-elasticity—The Civil Service Commission, Scientific Branch, 30 Old Burlington Street, London, W.1, quoting S.4315/54 (May 12).

ASSISTANT LECTURER (Grade B) IN GEOLOGY to teach the subject to degree level—The Registrar, Nottingham and District Technical College, Shakespeare Street, Nottingham (May 15).

SENIOR LECTURER (graduate in pharmacy, with adequate teaching and research experience) IN PHARMACEUTICS, and ASSISTANT LECTURERS, Grade B, in (*a*) PHARMACEUTICAL CHEMISTRY, and (*b*) CHEMISTRY, at Brighton Technical College—The Director of Education, Education Office, 54 Old Steine, Brighton 1 (May 15).

ASSISTANT, Grade A (honours graduate in physics) IN THE APPLIED SCIENCE DEPARTMENT, to teach physics and mathematics up to advanced level G.C.E.—The Clerk to the Joint Education Committee, Wolverhampton and Staffordshire Technical College, Wolverhampton (May 17).

ASSISTANTS (2) (with a sound training in laboratory methods, both physical and chemical, and preferably with some fundamental training and experience in biological work) for work on the composition of fruits in connexion with research on the storage life and quality of apples—The Secretary, East Malling Research Station, near Maidstone, Kent (May 17).

JUNIOR PHYSICIST to assist in physical and clinical work with radioactive isotopes—The Secretary, Institute of Cancer Research, Royal Cancer Hospital, Fulham Road, London, S.W.3 (May 22).

LECTURERS or SENIOR LECTURERS IN MATHEMATICS, BOTANY, CHEMISTRY, and a LECTURER IN CROP HUSBANDRY, at the University College of the Gold Coast—The Secretary, Inter-University Council for Higher Education in the Colonies, 1 Gordon Square, London, W.C.1 (May 22).

SENIOR PRINCIPAL SCIENTIFIC OFFICER (with first- or second-class honours degree or equivalent in mechanical or aeronautical engineering, with considerable engineering experience, and preferably with some knowledge of guided missiles or rocket propulsion, and a theoretical knowledge of gas dynamics), IN THE ROYAL AIRCRAFT ESTABLISHMENT ROCKET PROPULSION DEPARTMENT, to direct research and development work on liquid propellant rocket motors—The Ministry of Labour and National Service, Technical and Scientific Register (K), 26 King Street, London, S.W.1, quoting C.247/54A (May 22).

HEAD (with appropriate academic and teaching experience, and also with industrial and research experience) OF THE DEPARTMENT OF METALLURGY—The Registrar, College of Technology, Suffolk Street, Birmingham (May 28).

LECTURER/SENIOR LECTURER IN PETROLOGY at the University of Sydney, Australia—The Secretary, Association of Universities of the British Commonwealth, 5 Gordon Square, London, W.C.1 (Australia, May 29).

READER IN RADIOCHEMISTRY—The Registrar, University Office, 46 North Bailey, Durham (May 29).

LECTURER or ASSISTANT LECTURER IN PHYSIOLOGY at the University of Malaya, Singapore—The Secretary, Inter-University Council for Higher Education in the Colonies, 1 Gordon Square, London, W.C.1 (May 30).

CHAIR OF PHYSICAL or INORGANIC CHEMISTRY—The Secretary, Queen's University, Belfast (May 31).

DEMONSTRATORS (3) (with a first- or second-class honours degree in chemistry), and a RESEARCH ASSISTANT (with at least two or three years experience in postgraduate research work) IN THE DEPARTMENT OF ORGANIC CHEMISTRY—The Registrar, The University, Liverpool (May 31).

LECTURER (with special qualifications in organic chemistry) IN CHEMISTRY in St. Salvator's College—The Secretary, University of St. Andrews, College Gate, St. Andrews (May 31).

LECTURER IN PATHOLOGY—The Secretary, University College, Cork, Ireland (May 31).

METALLURGIST (with a recognized degree in metallurgy, and preferably with one or two years industrial experience) at the Naval Research Establishment, Halifax, Nova Scotia, for duties which will include the examination of service metallurgical failures (ferrous and non-ferrous) in R.C.N. Ships, and undertake metallurgical research in the field of the improvement of metallurgical components in warships—The Defence Research Member, Canadian Joint Staff, 66 Ennismore Gardens, London, S.W.7 (June 1).

LABORATORY TECHNICIAN (with wide experience in biochemical and/or chemical laboratories) IN THE DEPARTMENT OF BIOCHEMISTRY, John Curtin School of Medical Research, Australian National University—The Secretary, Association of Universities of the British Commonwealth, 5 Gordon Square, London, W.C.1 (June 7).

CHAIR OF PHYSIOLOGY in the University of Sydney, Australia—The Secretary, Association of Universities of the British Commonwealth, 5 Gordon Square, London, W.C.1 (Australia, June 30).

SENIOR LECTURER IN METALLURGY at the University of Otago, Dunedin, New Zealand—The Secretary, Association of Universities of the British Commonwealth, 5 Gordon Square, London, W.C.1 (New Zealand, July 1).

SENIOR LECTURER IN PHYSICS at Rhodes University, Grahamstown, South Africa—The Secretary, Association of Universities of the British Commonwealth, 5 Gordon Square, London, W.C.1 (South Africa, July 1).

AGRONOMIST (with at least a second-class honours degree, and not less than two years appropriate postgraduate experience, preferably including acquaintance with tropical crops and up-to-date knowledge of the statistical analysis of field experimental results), at the West African Cocoa Research Institute, Gold Coast, to assist in laying down field experiments on various methods of cultivating cocoa—The Director of Recruitment, Colonial Office, Great Smith Street, London, S.W.1, quoting 27059/130.

ASSISTANT, Grade B (with a good honours degree of a British university, and preferably with teaching experience to degree standard) IN THE DEPARTMENT OF PHYSICS—The Principal, Technical College, Queen Street South, Huddersfield.

ASSISTANT LECTURER (graduate in physics, engineering or chemical engineering, and preferably with experience in the food industry)—The Registrar, National College of Food Technology, Cranwood Street, London, E.C.1.

DEMONSTRATOR IN GEOLOGY—The Registrar, The University, Nottingham.

ENGINEERS and PHYSICISTS (particularly with electronics), Senior Scientific Officer and Scientific Officer grade (with an appropriate first- or second-class honours degree, or equivalent high professional attainments) in Royal Naval Scientific Service Experimental Establishments in the London, Portsmouth, Weymouth and Gloucestershire

areas, and in Scotland—The Ministry of Labour and National Service, Technical and Scientific Register (K), 26 King Street, London, S.W.1, quoting A.246/52A.

Fisheries Officers (with a university degree in natural science) in the Gold Coast, to assist in the general development of marine and freshwater fisheries (Ref. CDE.65/13/01), and in the Northern Region of Nigeria, to demonstrate and develop simple fish farming (Ref. CDE.149/14/02)—The Director of Recruitment, Colonial Office, Great Smith Street, London, S.W.1, quoting appropriate Ref. No.

Master to teach Mathematics to advanced and scholarship level—The Headmaster, Bishop's Stortford College, Bishop's Stortford.

Physical Chemist (preferably with research experience on polymerization) to undertake fundamental research on resin finishes on textiles—The Secretary, British Rayon Research Association, Barton Dock Road, Urmston, Manchester.

Physicist (with a first- or second-class honours degree in physics, and wide experience of high-speed photography including operation of electronically pulsed timing circuits) at the Ministry of Supply Designing Establishment, near Sevenoaks, Kent, to take charge of a small section employing photographic and optical techniques in investigation of transient phenomena associated with explosives—The Ministry of Labour and National Service, Technical and Scientific Register (K), 26 King Street, London, S.W.1, quoting A.108/54A.

Principal Scientific Officer (with first- or second-class honours degree in physics or equivalent qualification, and undertaken several years responsible research work) at the Atomic Weapons Research Establishment, Aldermaston, to supervise a group engaged on research and development work in relation to problems involving radioactive materials—The Administrative Officer, Recruitment, Atomic Weapons Research Establishment, Aldermaston, quoting 78/WGE/34.

Scientific Officer, Grade 2 (with professional/academic qualifications, and preferably with industrial experience in metallurgy) in the Metallurgy Division at Derby—The Director of Research (Railways), British Railways Research Department, Staff Section, 222 Marylebone Road, London, N.W.1.

Scientific Officer (with first- or second-class honours degree in physics or electrical engineering) at an R.A.F. Station near High Wycombe, Bucks, for operational research duties, and theoretical studies in the field of communications and general electronics—The Ministry of Labour and National Service, Technical and Scientific Register (K), 26 King Street, London, S.W.1, quoting A.109/54A.

Soil Chemist (with a good honours degree in chemistry, preferably with training and experience in soil chemistry) in Kenya, to analyse soils in connexion with research into the uses of fertilizers on crops, and into the development of areas of irrigation—The Director of Recruitment, Colonial Office, Great Smith Street, London, S.W.1, quoting CDE.63/7/017.

Zoologist, Senior Scientific Officer or Scientific Officer grade (with first- or second-class honours degree), for general and experimental work on marine plankton—The Director, Marine Station, Millport, Isle of Cumbrae, Scotland.

REPORTS and other PUBLICATIONS

(not included in the monthly Books Supplement)

Great Britain and Ireland

Royal Institute of Chemistry. Lectures, Monographs and Reports, 1954. No. 1: The Development of Radiation Chemistry and Radiochemistry. By Sir John Cockcroft, F.R.S. (Eighth Dalton Lecture.) Pp. ii+12. (London: Royal Institute of Chemistry, 1954.) [252

The Agricultural History Review. Vol. 1—1953. Pp. 64. (Annual subscription 21*s.*) (Reading: British Agricultural History Society, 1954.) [252

Flora of Tropical East Africa: Turneraceae. Edited by Dr. W. B. Turrill and E. Milne-Redhead. Pp. 20. (London: Crown Agents for the Colonies, 1954.) 1*s.* 8*d.* [252

Colonial Office. Fishery Publications, No. 5, 1954: Fertilizers in Fishponds. By Dr. C. H. Mortimer. With additional material and a foreword by Dr. C. F. Hickling. Pp. iv+156. (London: H.M. Stationery Office, 1954.) 25*s.* net. [252

Ministry of Agriculture and Fisheries. Technical Bulletin No. 4: The Calculation of Irrigation Need. Pp. vi+38. (London: H.M. Stationery Office, 1954.) 2*s.* net. [252

Siemens Brothers and Co., Ltd. Engineering Bulletin No. 269/70, February/May, 1953: Plymouth "B" Power Station. Pp. 12. (London: Siemens Brothers and Co., Ltd., 1954.) [252

Philosophical Transactions of the Royal Society of London. Series B: Biological Sciences. No. 649, Vol. 237, 17 February 1954: A Biometrical Study of *Micraster coranguinum* and *M.* (*Isomicraster*) *senonensis*. By K. A. Kermack. Pp. 375–428. 16*s.* No. 650, Vol. 237, 17 February 1954: British Hyprogeous Fungi. By Lilian E. Hawker. Pp. 429–546. 27*s.* (London: Cambridge University Press, 1954.) [252

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